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VOL. XXI. REGULAR EDITION NO. 597.

ARCHITECTURE

ENGINEERING

DECORATION

CONSTRUCTION

TICKNOR & COMPANY

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Armory for the First Corps of Cadets, M. V. M., Boston, Mass.
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Building of the Young Men's Christian Asso., Worcester, Mass.
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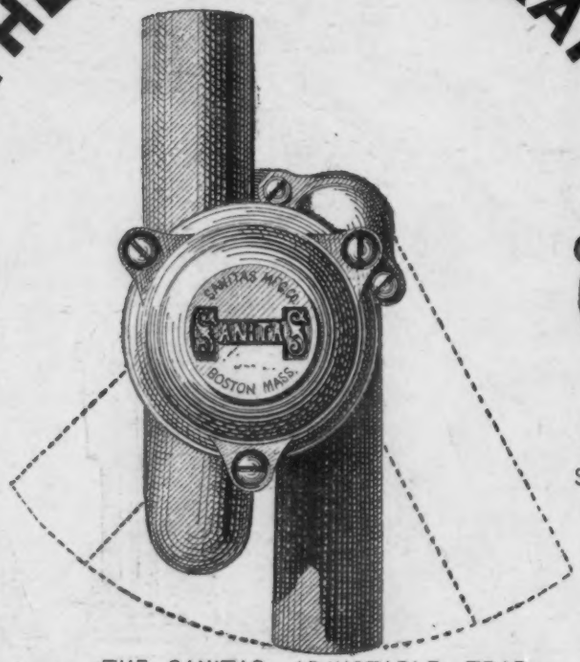

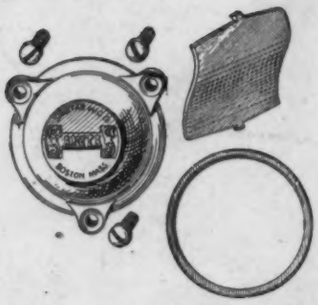

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THE Archæological Institute of America begins its tenth year with encouraging prospects, although nothing of extraordinary interest has been accomplished during the past twelve months. An attempt was made by its indefatigable explorer, Mr. Joseph T. Clarke, to investigate some interesting ruins in Magna Græcia, but the owner of the land objected, and the Italian Government put a summary stop to the operations. Enough has, however, been ascertained in various parts of Southern Italy to show that an immense amount of valuable archæological material lies hidden there, waiting for the work of the explorer. The American School at Athens, which the Institute probably regards as the nucleus of its activity, has been provided with a house of its own, and now needs an endowment for the support of a permanent director, in place of the volunteers who have been sent out from year to year by various colleges. Some progress has already been made toward the provision of such an endowment, and it is hoped that a fund of one hundred thousand dollars will be raised in time to secure the services of Dr. Waldstein, the most noted of all American archæologists, who has promised to accept the directorship if the endowment is soon made complete.

ONE of the most terrible theatre fires ever recorded took place a few days ago in Paris, where the Opéra Comique, perhaps the most popular theatre in the world among intelligent people, took fire, and was destroyed, together with about two hundred of the audience. It is the boast of the French that their theatres are very substantially built, but, to make up for this, the ways to get out of them are often long and narrow, and if a panic breaks out, a disaster is sure to follow. In this case the building, which served as the home of the Italian Opera until the present opera-house was constructed, was, like the new one, made almost entirely of iron and stone. This, however, did not save either it or its occupants from the effect of a conflagration which broke out on the stage. The fireproof curtain, which is now regarded as an indispensable part of modern theatre fittings, seems here to have been wanting, or not in condition for use, and, indeed, a false feeling of security seems to have prevailed all over the theatre. According to an American among the audience, who escaped with his life, the light of a fire among the stage machinery had been visible from the seats near the proscenium for some time before it attracted the attention of the rest of the spectators. When a movement in the house showed that the increasing flames had been observed, one of the singers, in a well-meant effort to prevent panic, announced from the stage that the fire was trifling, and begged the spectators to remain quiet. They obeyed, unfortunately for themselves, and in a moment a rush of fire through the proscenium arch filled the auditorium with smoke, and sent the audience, frenzied with terror, in mad confusion toward the doors. As usually happens in such cases, a large part, perhaps all, the persons in the gallery were suffocated before they could get out, and of the others scores were trampled upon or burned; while on the stage, which was nearer the fire, the destruction of life was even more rapid and complete. The lesson of the catastrophe seems to be the old one, that no theatre, however incombustible, can preserve its occupants from death if the smoke and flames from burning scenery on the stage is allowed to get into the auditorium; and it should be noticed also that the slight delay caused by the reassuring words of the actor proved fatal to many persons. The temptation to cool-headed persons to check a panic by underrating the danger is very strong, and those who value their lives should remember this. Until theatres are built in a manner very different from that now in use, the wisest course for a spectator is, as soon as an incipient blaze is seen or reported on the stage, to run instantly for the nearest door. It should not be forgotten that the longest interval known to have elapsed between the entrance of flames from the stage into the auditorium, and the complete extinction of life among the persons remaining in the room, is seven minutes, while the average interval is only about five minutes. Now five minutes is a short time to get out of a theatre in a crowd, even for persons not choked and bewildered with smoke and terror, and only those can hope to succeed who start early and move quickly.

EVERY one who takes an interest in the architecture of the Middle Ages will hear with sincere regret of the death of M. Ruprich-Robert, which occurred at Cannes a few weeks ago. M. Ruprich-Robert, as we learn from the *Courrier de l' Art*, was born in Paris in 1820. He showed, when quite young, a strong inclination toward the study of architecture, and was placed with M. Constant-Dupaix, under whom he pursued the course at the Ecole des Beaux-Arts. Even at that day he exhibited an interest in the forms of mediæval architecture, which, though not calculated to win for him the suffrages of the juries of the *Concours*, brought him, later, an appointment on the Commission of Historic Monuments. For this Commission, to which he was attached during the remainder of his life, he made many drawings and restorations, and designed a good deal of new work in his favorite style, of which he was recognized as, perhaps, the most consummate master after Viollet-le-Duc. Being naturally of an active and enthusiastic disposition, he had frequent occasion to defend his ideas, or criticise those of others, and showed always a clearness of thought and expression which made his articles interesting reading, even for those who did not agree with their author's opinions. These occasional papers were followed by more permanent books, of which the beautiful work on Norman architecture, which is not yet quite finished, is the latest and best known. Although fond enough of controversy to be almost constantly engaged in some dignified dispute on archæology or architecture, he was sincerely devoted to his profession, participating in all movements and discussions which he thought likely to benefit it, and often contributing greatly to the efficient conduct of them. In him the mediæval party in French architecture loses the last of its great leaders. There are still plenty of mediævalists left, but they seem to lack the aggressive enthusiasm of Ruprich-Robert and Viollet-le-Duc, and their influence upon public taste is likely for some time to be quite insignificant.

WE are glad to see that one of those airy editors, who delight in ascribing all sorts of imaginary blunders to architects, has come to grief, and, through the persuasion, it would appear, of the counsel for an architect whom he had used to make a joke about, has been induced to make a very humble apology, the recollection of which will probably prevent him from meddling with the profession for some time to come. The architect who had the courage to bring to justice the author of certain entertaining reflections on him was Mr. W. H. Crossland, the architect of the splendid Holloway College buildings, near London. The buildings are all finished, and ready to be opened as soon as the officers are chosen and the necessary apparatus of instruction provided. As the managers of the college did not see fit to take the public into their confidence while these points were being arranged, there was some wonder expressed at the delay, and the editor of the *Journal of Education* volunteered to explain it by saying that "it was reported that the delay in opening the Holloway College had been occasioned, not only by the difficulty of choosing a principal, but also by a more substantial impediment, the absence of drains, a detail that architects have a way of overlooking." The idea of an architect's forgetting the drains of a costly building would appear to any one in the profession too absurd to be seriously

entertained; but the public readily swallows assertions of this sort, and most of the readers of the *Journal of Education* probably thought, with smiles, how much better they could have done the work than those poor fools in general who practise architecture, and the architect of the Holloway College in particular. Mr. Crossland, hearing of this, seems to have placed the matter at once in the hands of his lawyer, who, a few days later, sent to the architectural journals for publication a letter from the editor of the *Journal of Education*, saying, in regard to the statement about the absent drains, that, on inquiry, he had satisfied himself that the report was wholly without foundation, and that, on the contrary, the drains were complete, and had been highly approved by Sir Robert Rawlinson. The letter went on to express much regret that the statement had been made, and concluded with a formal assent to the publication of the apology. As the statement of the *Journal of Education* was quite as much a reflection on other architects as on Mr. Crossland, we think that the whole profession is entitled to participate in the apology, and are glad to give it as wide publicity as possible.

THE accounts of the earthquake in Mexico ought to make still more evident than before the part which skilful architects may take in making buildings in earthquake countries secure; and if no other good comes from such occurrences, every shake at least calls the attention of intelligent people to the essential difference between a well-built and a badly-built house. The Mexican buildings are, as a rule, constructed of soft stone, not too well put together, and are, in consequence, easily cracked and dislocated by movements which would not injuriously affect a piece of well-executed masonry, so that the lightness of the shocks alone appears to have saved the city from a serious disaster. The frightful earthquakes of last year on the Riviera gave still stronger proof of the certainty with which movements of the ground search out the weakness of walls. In that country the ordinary building material is an incoherent rubble of small stones, stuck together with the lime-mortar which the Italians make so well, and plastered on the outside with a coat of the same, which, when washed with pink or yellow, with white window dressings moulded in relief in the same material, has a substantial appearance which is quite deceptive, and walls of this material are often carried to a great height and length, as in the immense hotels which line the beach at Nice. When finished, all these rubble structures look alike, and whatever bond may exist in the hidden masonry is likely to be due to the care of the architect in drawing up his specifications, and his vigilance in seeing them carried into execution. The Italian mortar is so admirable that walls with no bond at all will resist for centuries the ordinary disintegrating influences; and any one but a conscientious and faithful architect is very likely to forget or neglect the selection and interlocking of the stones themselves by which alone the wall is given permanent tenacity; but the slightest trembling of the earth tears apart the mortar of a wall not properly bonded, and a stronger shock throws the whole down in a heap. In the smaller towns, such as Porto Maurizio and Diano Marina, where the buildings were all of the cheapest and poorest construction, hardly anything resisted the earthquake, and there the loss of life was terrible; but in Nice, which pretends to possess a highly-developed architecture, the losses were confined almost exclusively to the buildings which were inwardly of bad workmanship, although these included some of the most ambitious and showy structures in the city, among others, we believe, the new concert-hall built by the municipality, and one or two of the finest hotels. The houses built with care, under expert direction, escaped serious injury, we believe, without a single exception; and so obvious was the reason of their immunity to those who compared them with the buildings destroyed that in one instance the owner of a new house which had passed through the earthquake without injury, while those of his neighbors were falling upon their inmates, hastened in search of his architect, as soon as the confusion had subsided, to thank him in the warmest manner for the skill and faithfulness to which he and his family had perhaps owed their lives. It is not often that an architect receives such a recognition of his care, and perhaps nothing less than an earthquake would have called it forth. Under ordinary circumstances the proprietor of a house built as it should be, among a score of others built as they should not be, would have been far more likely to upbraid his architect for having made his house cost a few francs more than those of his neighbors through his ridiculous fussiness, and to injure his business by disseminating complaints of his extravagance, than to thank him for his conscientiousness; and the poor professional man would have to solace himself as well as he could with the knowledge that he had done his duty; but it should be remembered that the object of faithful work is to prepare for the time of trial, not for that of prosperity, and the sneers and misrepresentations of years would be far more than compensated by the consciousness that one's skill had saved his employers from pain or loss.

AN immense amount of work is being done just now in changing the face of nature so as to open new routes for communication, either by sea or land, or to reclaim districts unfitted at present, through natural causes, for habitation. In Russia a vast work of drainage has been accomplished, by which a tract of marsh and lake in the southwestern part of the empire has been converted into an extremely fertile district of great extent. In Italy the Prince Torlonia has completed his undertaking, of draining the fertile tract which has for ages been covered by the waters of Lake Fucinus, in the highlands which border the Campagna. This work was accomplished by boring a tunnel through one of the enclosing mountains, and it was discovered, as the excavation went on, that the Romans had endeavored to do the same thing in the same way nearly two thousand years before. In Africa, the scheme to which the late Captain Roudaire gave his life is likely to be carried out, after a fashion which he never contemplated, and which seems likely, hereafter, to give some trouble to those scientific persons who helped to disappoint him by their predictions of the impracticability of his plan. It will be remembered that he wished to interest the French Government in the excavation of a canal from the Mediterranean to the low lands in Tunis, lying at some distance from the sea, but at a lower level. His idea was that the flooding of this tract would not only render fertile a large territory in Africa, but would also, in some degree, moderate the dryness of the South winds on the coast. All sorts of objections were raised to his scheme by scientific men, some of whom asserted that his canal could not supply water fast enough to make up the loss by evaporation, and that the lake would soon become a mass of salt. The French Government appointed a commission to examine the ground and see whether Captain Roudaire's theories were well founded; but this commission, after taking careful levels through the country, reported that the area which would be overflowed by the canal was much smaller than the captain thought, and it was decided to be unwise to go to the expense of constructing the canal for so small a gain. In the course of the explorations an artesian well was sunk in one of the low-lying districts, and at the depth of about three hundred feet water was struck, which rose fifteen feet above the mouth of the shaft. For the first year the flow averaged only seventeen or eighteen hundred gallons a minute, but it increased very rapidly, and is now about twenty thousand gallons a minute, the waste forming a river of tolerable size, along the banks of which vegetation is springing up, while families of Arabs are coming from all quarters to make for themselves permanent habitations in the neighborhood. So far, the water has shown no disposition to dry up and leave nothing but salt behind it, and new wells are to be sunk at once, and a regular system of irrigation introduced throughout the region.

THE Fahlberg "saccharine" seems destined to play before long a considerable part in the commerce of the world. Patents have been taken out in various parts of the world, and the manufacture of artificial sugar has been already begun. In the opinion of the inventor, the artificial compound will not at present compete with the cane sugar of the West Indies, but he thinks that the persons interested in the production of beet sugar, which is the universal sweetener of continental Europe, would do well to plough up their beet fields at once, and sow them with wheat, and take steps toward the conversion of their vacuum-pans and filters into apparatus for the treatment of glucose and saccharine, or, as the scientific men prefer to call it, anhydro-ortho-sulfo-benzoic acid. It seems to be proved that the substance, notwithstanding its name, is in no way poisonous or injurious, and even if the sale of the counterfeit sugar produced by its use should be prohibited, as the beet-root people would like, it is hard to see why it cannot be used with perfect propriety in preparing syrups, preserves, jellies, and many other things which now consume vast quantities of sugar. In fact, many tons of glucose are already used for this purpose, and the addition of some fresh sweetening to the glucose could hardly make it objectionable.

EARLY SETTLER MEMORIALS.[1]—X.

DETROIT, MICH., AND THE JESUITS.

Statue of Antoine de la Mothe Cadillac, City Hall, Detroit, Mich. J. Melchers, Sculptor.

THE early history of the Catholic priests and Jesuits in America reads like a fearful fairy tale. It needs no assistance of the imagination to picture them to the mind of the reader as veritable spirits sent from heaven for the purpose of human sacrifice. Their loyalty to their religion, and the sufferings they endured at the hands of the American Indians are almost incredible. All other enterprises in the cause of religion, civilization, or discovery, seem tame and colorless when compared to those undertaken and carried through by the forerunners of the Catholic faith in the limitless wilderness of Canada and the great West. The writer regrets that it is not in the purpose of these articles to give even a short account of the wonderful performances of these religious pioneers.

Save the rude pictures and statues found in Catholic churches and convents, no memorials of importance have been erected to their inspiring memories.

In 1884, Hon. Bela Hubbard, a wealthy and public-spirited citizen of Detroit, caused to be placed in niches on the outside of the City Hall, the statues, cut in Ohio sandstone, of the priests Marquette, La Salle and Richard, and of Cadillac, the founder of that city. We have been unable to get any information concerning their cost, and only succeeded in finding a small photograph of the plaster model from which the Marquette was executed, and a miserable wood-cut of the figure of Cadillac. The history of these statues is like that of many others that are scattered here and there over the country. Some one is willing to give money to pay for them, anybody who can murder clay and stone makes them, they are put in their places, and that is the end of them so far as art or any earthly interest is concerned. The mere fancy to spend a little money on a wretched statue is deserving of very little commendation. In one respect, at least, Detroit is less pretentious than Plymouth, for Marquette and his fellow images are out of the sight of passers-by, whereas the Plymouth caricatures cannot be escaped. The statue of Cadillac was made by Mr. Julius Melchers, and Marquette, La Salle and Richard by Mr. John M. Donaldson,

Statue of Pere Marquette, City Hall, Detroit, Mich. J. M. Donaldson, Sculptor.

JAMESTOWN, VIRGINIA.

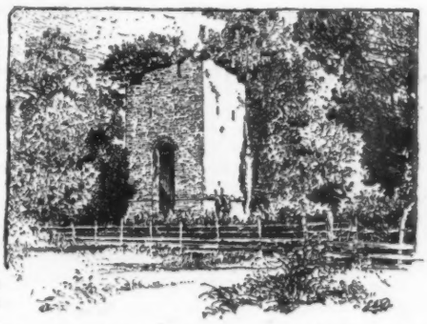
The first permanent English colony in North America was made at Jamestown, Va., May 13, 1607. The leader among the settlers, who numbered one hundred and five men, without women or children, was Captain John Smith.

The party was made up of "useless gentlemen," a few mechanics or farmers and some pardoned criminals, all adventurers, looking for gold. They were reckless and wasteful, building a church that cost fifty pounds and a tavern that cost five hundred. When the wives and children of these men came out to them, and when they began to have comfortable homes they did better. Smith went to England in 1609, and never returned. After his departure things grew worse and worse among the emigrants; and in six months they left Jamestown in despair, meaning to return to England, but on the way down the James River they met the long-boat of a vessel which was bringing them supplies and a new governor, Lord de la Ware, or Delaware. They then returned to Jamestown.

The settlers in Virginia did not generally live in villages, like those of the more Northern colonies. The soil was so productive, and the cultivation of tobacco so profitable that the men paid little attention to commerce or the fisheries; and they were not, like the Eastern colonists, obliged to live near one another for protection against the Indians. So no large towns were established; but they cultivated separate plantations, and it became the practice to send out "apprenticed servants" from England, who were sold for a certain number of years to the planters. These servants were men who had committed crimes, or rebelled against the government, and who were sent to America in order that they might be of some use. In 1620 a Dutch trading-vessel brought a cargo of twenty negroes from Africa, and the planters eagerly bought them, thus laying the foundation for the institution of slavery. In the early days of the colony ninety respectable young women were sent out from England; and whoever took one of them for a wife was obliged to pay a hundred pounds of tobacco. In 1671 a Virginia governor said, "I thank God there are no free schools nor printing; and I hope we shall not have them these hundred years." Another governor gave orders "to allow no person to use a printing-press on any occasion whatever"; and still another taxed school-masters twenty shillings a head. Yet William and Mary College, in Virginia, is, next to Harvard, the oldest college in America, having been founded in 1692. It had twenty thousand acres of land from the English king and queen, for whom it was named.

Nothing could exceed, in tyranny, the laws by which the first Virginia settlers were governed by the king of England and his council. The early history of the settlers has many pages of a most disreputable nature. Many of the clergy were given to drunkenness, gambling and other vices. After a time the people of Virginia secured the right to govern themselves. At the time of the American Revolution Virginia was the leader among the colonies, the first to propose separation from the mother country, and furnished many of the ablest men, both in Congress and in camp.

Nothing remains of the famous settlement of Jamestown but the ruins of a church-tower about twenty feet high, some old tombstones, and the almost indistinguishable masonry of a magazine. The tower is crumbling year by year, the roots of the trees have intermingled with the bones of the dead, and the stones, upon which could once be read the names of the "Armigers" and "Honarables," are broken in pieces, impenetrably hidden by brush and briars, and become lost to the sight of man.



Ruins of Church-tower on Jamestown Island, Va.; believed to have been built in 1709.

The place once occupied by the huts of the first settlers is already covered by the sea, and naught is heard in this desolate locality but the noise of its ever-encroaching waves, and the fitful cry of the seafowl as it flits hastily by.

War, fire, and public indifference have brought desolation to William and Mary College. Neither light-hearted student, nor learned and self-sacrificing professor treads its grass-grown campus or breaks the silence of its halls. As each September comes drearily around, the old gray-haired president goes to the bat-inhabited belfry and rings out a peal that wakes no echo save in the histories of those who once animated its walls.

ABRAHAM PIERSON.

Yale College was founded in 1700 by ten ministers belonging to the colony of Connecticut, who came together in the town of Branford, bringing with them a number of books, which they placed together upon a table as each minister pronounced these words: "I give these books for the founding of a college in this colony." The Rev. Abraham Pierson, of Clinton, was chosen as the rector of the divinity school, or the first president of the college. The old, red sandstone tablet, erected to his memory in the cemetery in Clinton bears the following inscription:

"In Memory of WORSHIPFUL ABRAHAM PIERSON, Esq^r
Who died Jan^y 8th 1752 in His 79 year."

Very many years ago the professors of Yale College erected on Meeting-house Hill, in Clinton, the base stones of the column monument, and on the top of the stone which now serves as the plinth of the column, they intended to place an hour-glass. But this appropriate completion never having been made, Gen. William A. Pierson, of Windsor, Conn., the only living male descendant of the first president, erected, some years ago, the column, cap, and books as they now appear. One side of the die bears a latin inscription, on another side are the words: "The earliest senior classes of Yale College were taught near this spot by Abraham Pierson, 1701–1707." The cap of the column is inscribed with the words uttered at the time of giving the books. The weed-covered and almost indistinguishable spot of earth that encloses the remains of the reverend rector appears to have been quite forgotten by those who made the monumental pile or set up the brazen images.

In 1872 Charles Morgan, Esq., of New York, a native of Clinton,

[1] Continued from page 222, number 593.

and the founder of the Morgan School in that town, commissioned Mr. Northrop, the secretary of the Board of Education of the State of Connecticut, to procure duplicate bronze statues of Pierson, one to be placed on the grounds of Yale College, and the other in the yard of the Morgan School.

Several sculptors were asked to make sketches for the statue, and after the usual amount of competitory contention that generally characterizes matters of this kind, the commission was finally given to Mr. Launt Thompson, of New York, by the decision of the authorities of the college. Owing to certain unsatisfactory circumstances occurring previous to the decision there was some doubt entertained by various persons in regard to its justice. Accordingly, one of the professors of the college who had favored the decision, and taken part in it, was asked for an explanation, and why Mr. Thompson was selected in preference to any one else. The explanation was also asked because it was thought that a committee of scholars would show a finer and more comprehensive judgment in a matter of this kind than the ordinary committeeman. "What could we do?" said the professor. "None of us knew anything about art, and we did not wish to take any responsibility in the matter. I have no reason to believe that Mr. Thompson can make a better statue than A or B, but he has a popular reputation, and we depend upon that. If he fails the blame will be on his shoulders, not on ours." "But was it not right to expect that you would act from a higher and more critical point of view than that which governs the average citizen. That, certainly, was expected." "Well, the fact is, we did not feel like making experiments, and we had to trust to what is popularly thought of Mr. Thompson, not on an examination of what he has done or can do." Another professor, when asked the same question, made much shorter work of it. "Mr. Thompson had the inside track and the strongest personal backing." After the statue was erected the first professor was asked what he thought of it. "It is good enough. It is draped in the costume of the period. The public won't know the difference between this and a better one." "But is this the position that an institution of learning should take in the matter of public statues? Is the representation of costume in bronze all there is to a statue?" "Well, it seems to be about all that the sculptor has got out of Pierson."

The Pierson Monument, Clinton, Conn.

The copy intended for Yale College was unveiled in June, 1874, in the presence of the college corporation, many alumni, the State government, and a large number of citizens.

In all that was said during the dedicatory ceremonies no allusion of any significance was made to the statue as a work of art, or of Pierson as an ideal subject for sculpture. The times in which he lived were commented upon by Governor Ingersoll; Ex-President Woolsey spoke of the meagre history of the founders of the college, and the Rev. Dr. Leonard Bacon gave a biographical sketch of the first president. The only thing about the statue which the reverend gentleman cared to notice was, that the book which Pierson held in his right hand was copied from an old Indian volume entitled "*Cartwright's Commentary on the Book of Proverbs.*" The only recognition of the statue by those present began and ended during the moment the event of unveiling took place.

Abraham Pierson, New Haven, Conn.
Launt Thompson, Sculptor.

Mr. Morgan had also a statue of himself, made by Mr. Thompson, and erected with its companion, the duplicate Pierson, in front of the school-house in Clinton. We should make no criti.al allusion to the Pierson or Morgan statues, for the reason that they would not be called sculpture by any proper interpretation of that word, were it not for the fact that they are the work of a sculptor who was selected by the authorities of one of the largest and most influential institutions of learning on this continent, and which has had connected with it for more than twenty years an extensive museum and school of fine arts. The Pierson represents what the college was able to get in the matter of sculpture.

Gen. John Sedgwick, West Point, N. Y.
Launt Thompson, Sculptor.

Admiral Dupont, Washington D. C.
Launt Thompson, Sculptor.

In the *American Architect* of October 2, 1886, we referred to the continual habit of influential newspapers and magazines of berating the "vulgar pretenders in art," the "art contractors," and "the builders of ungainly statues and monuments," and of laying the entire blame for the multiplicity of these objects at the doors of this class of unnamed persons. We venture to suggest that it would be found, upon examination, that these wretched statues and monuments were the result of a public approval, expressed by eminent representatives of what are known as art-lovers, amateurs and artists, as well as the innocent dwellers in the rural districts. The big pile of granite in Plymouth, known as the National Monument to the Forefathers, is an illustration of the correctness of this suggestion. Its existence is due to the support given to it by the representative citizens of New England. The Pierson and Morgan statues are also illustrations. The conversation with the professors of the college, above quoted, shows that the authorities of Yale were quite as incapable of solving the difficult preliminary question of how to get a work of art in sculpture as the ordinary committeeman.

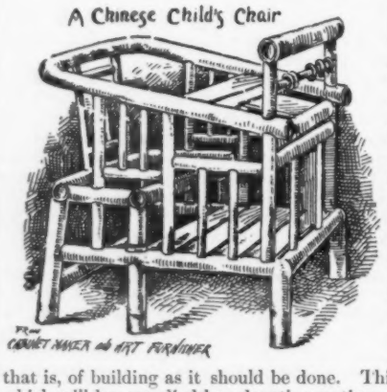
The Pierson and Morgan, like all of Mr. Thompson's statues, of which we give several illustrations, are lacking in many of the qualities of sculpture.

T. H. Bartlett.

[To be continued.]

HINTS FOR BUILDERS.[1]—II.

BRICKLAYING.



Passing on from drainage, I come now to a brief consideration of the intimately associated work of bricklaying. Many persons who set themselves up in the present day as builders—and even occasionally as architects—are nothing more nor less than bricklayers, who, though capable of laying a course of brickwork in a proper and workmanlike manner, are yet totally incapable of building—that is, of building as it should be done. This is, however, a matter which will be remedied by education as time goes on.

[1] Continued from page 168, No. 588.

Bricklaying, known alike to the ancient Egyptians and Romans, is the art of building with bricks or of uniting them by the aid of cement or mortar into various shapes or forms, for the serving of a multitude of purposes. Bricks are generally made in one size and form — an oblong about eight inches in length, four inches in breadth, and two inches in depth. Their quality varies greatly, this depending upon the quality of the material employed, the manner in which the clay is tempered, and the method pursued in the burning of the brick.

It may here be mentioned that the bricklayer executes his work with a few and exceedingly simple appliances, these consisting of a brick trowel, made of well-tempered steel, and which contrives a "double debt to pay" in the spreading of the mortar and the cutting, by concussion, of the brick; a hammer, for cutting holes and chases in brickwork, and also for driving or dividing bricks, for which reason, in order to adapt it to these various requirements, one end is fashioned like the ordinary household hammer, while the other is furnished with a species of small axe; a plumb-rule, consisting of a thin rule about half-a-dozen inches in width, with a line and plummet swinging in the middle, the use of this implement being to guide the workman in carrying up walls perpendicularly; the level, ranging from ten to twelve feet in length, having a vertical rule attached to it, to which a line and plummet are suspended, and the use of which is to try the level of walls at various stages o· the building as it proceeds, and especially, at window-sills, foundations and wall-plates; the large square, employed for the setting-out of a side of a building at right angles; the rod, usually either five or ten feet in length, and used for measuring lengths; the jointing-rule, about eight feet in length and four inches in breadth, with which the operator runs or marks the centre of each joint of the brickwork; the jointer, an iron tool shaped somewhat like the letter S, and employed with the preceding tool for marking the joints; the compasses, for traversing arches and vaults; the raker, a piece of iron having two knees or angles, the points of which are employed for removing decayed and old mortar from the joints of old walls, previously to repointing them; the hod, with which I doubt not my readers are sufficiently acquainted as not to necessitate a description here, and with which the brick-layer proper seldom has anything to do, the helper usually having charge of this.

Among other tools required are the line-pins and line, for the regulating of each course of bricks, the rammer, an iron crow and pickaxe, grindstone, hammers, etc., these not being requisite for each individual bricklayer employed on a job, but rather as being included in the apparatus at command generally. When it is required to prepare and cut gauged arches, the following appliances in addition will be required: a banker, which consists of a bench from six to twelve feet in length, from two-and-a-half to three feet in width, and about three feet in height; a camber-slip, which consists of a piece of wood about half an inch in thickness, having one edge curved, and rising about one inch in six feet, and which is employed for the drawing of the soffit-line of straight arches. When the lower edge is curved, it rises to the extent of half an inch in six feet for the purpose of drawing the upper line of the arch, so as to prevent its getting hollow by settling. The upper edge is not invariably cambered, and when the slip is sufficiently long, it answers for the width of a variety of openings; a rubbing-stone, a rough-grained stone, which is fixed on a bed of mortar at one end of the banker, the gauged bricks being rubbed smooth on this stone; a bedding-stone, consisting of a piece of marble nearly a couple of feet in length, of about ten inches in width, and of any convenient thickness, its use being to try the rubbed surface of a brick upon, so that the brick may fit truly upon the skew-back or leading-end of an arch; a square, for testing the bedding of the bricks and the soffits; a bevel, for drawing the soffit-line on the face of the bricks; a mould, for forming the face and back of the brick, used in order to reduce it to its proper taper, this mould having a notch for every brick of the arch; a scribe, which can be made out of a sharp nail or bit of thin iron; a tin saw, necessary for cutting the soffit-lines about an eighth of an inch deep, first, by the level edge on the face of the brick, then, by the square edge on the bed, in order to enter the brick-axe, and prevent the brick from spalling. The saw is likewise employed for cutting the soffit through its breadth in the direction of the tapering lines upon the face and back edge, and also for cutting the false joints of headers and stretchers; a brick-axe, for axing off the soffits of bricks to the saw cuttings and the sides to the lines drawn by the scribes, and the truer the bricks are axed, the less rubbing will they require; a templet, employed for taking the length of the stretcher and the width of the header; a chopping-block, for reducing the sizes and forms of bricks, and generally made out of a piece of rough wood six or eight inches square; and a float-stone, used for rubbing curved work smooth, such as the cylindrical backs and spherical heads of arches, which will complete the outfit of the bricklayer.

Although many of these appliances have now been done away with through the introduction of machinery, still I have thought it quite as well to give them a place, as, in a new country especially, there may be times and places when the "resources of civilization" in the shape of machine-made bricks turned-out to any and every design and fashion would not be available, and where, consequently, the processes which found favor with our forefathers would not be unacceptable. Therefore, though old-fashioned, I trust the foregoing will not be unacceptable to my younger readers, upon whom I would impress that they can never acquire too much knowledge, as portions of it, at least, are bound to be remembered, and to crop up for application practically when least expected.

It will not be out of place, I think, if I make a few remarks upon the general descriptions of bricks in use, as it is quite as important for an artificer to know what he is working *with* as to know how to work with it, and although to my older readers I shall be going over well-trodden ground, still to the younger members of my *clientèle* such will not be the case. I shall, of course, avoid all technicalities, and I shall not give the chemical composition of those slabs of baked clay, known from the time of the ancient Egyptians, but shall simply confine myself to bricks as we find them.

Foremost among these must, of necessity, be placed the old-fashioned stock-bricks,[1] which are employed for internal walls and foundations, and which bricks are divided into several classes — best malms for rubbers, second malms for facing, and malm paviors or shippers for facing or paving, these last being admirably adapted, from their hardness and soundness, for export. The earth employed in the manufacture of these is passed through a wash-mill, to free it from any stony and gritty impurities, and consequently the bricks are of a very superior quality. Then come picked stocks, common stocks, rough stocks, grissels, places, shuffs, and burrs.

In the first instance, these classes are not made as such, the classification taking place after they have passed through the process of burning, which does not take place in kilns, like others, but in what is known as a clamp, and it is while the breaking-up of the clamp is going on that the bricks are classified. It is from the peculiar nature of the ingredients of which they are composed that these bricks actually burn each other, the only fuel used being a few layers of cinders, these layers being placed between the rows or bolts of green bricks when being stacked in the clamp. As may be imagined, the various degrees of burning decide their respective classes, the first being the shuffs. These are of least value, often falling to pieces in the handling. Next come the places, which are a trifle sounder. Then follow the grissels, which, though better baked, have not taken the heat uniformly, and after these come the common stocks, which, though still better baked, are yet more or less imperfect. Then follow the picked stocks, which are the best with the exception of the washed stocks. The rough stocks are those which, having become so calcined and knocked out of shape through the concentration of the heat, are of no avail in walls, but which can be used in foundations or in the centre of very thick walls, and even then they are not very desirable. Next come the burrs, which are blocks consisting of from two to a dozen bricks welded together, and which come in very handily for rockwork in pleasure-gardens, or for rough walls. Then of the most superior description, namely, the washed stocks, there are malms, malm-seconds, and paviors. The first of these three are the very finest of all stock-bricks. They are of a warm yellow or buff color, and, from the mild nature of the earth from which they are manufactured, they are fitted for cutting and rubbing in gauge-work, though even for this they are not without a fault, this being the numerous small air-cells formed in the body of the brick during the process of burning. The second of the bricks mentioned above — the malm paviors or shippers — are those selected from the malms and seconds on account of being burnt too hard to be used as cutters, and too dark to be employed with the seconds as facing bricks, but they make capital facings when used entirely by themselves. They are also very durable, and will sustain almost unlimited pressure in piers and walls. Red bricks, kiln-burned, of late years, have been very extensively employed in England, owing largely to the revived taste for Queen Anne architecture, but, owing to their great cost, are seldom employed for other than facings. I now come to the white kiln-burned bricks, which, owing to their great absorbent qualities, are ill suited to large cities or manufacturing centres.

I come now to gaults, which, like stocks, are divided into classes, the best being known as number one. These are, in a certain stage of dryness, between the time of moulding and burning, passed through a die, which has the effect, by the use of a very powerful press, of compressing the still yielding clay into a more regular and symmetrical form, which they will retain when burnt. They are usually reserved for facing. Then there are the pinks, so named from the color they assume when burning. They are very sound bricks, and make excellent and durable work, and their only difference from number two is the color. Before using, they should be saturated thoroughly in a tub, except in winter, when there is a danger of frost attacking them. These bricks are perforated, each brick having a number of circular holes passing through it, these being effected by a machine in the moulding. They are not fitted for sound work, as they are liable to twist in the burning. They are classed as whites and pinks. A very durable brick, and employed very extensively locally, are the Staffordshire blues, which are capable of sustaining a tremendous weight when used in walls and piers. There are many other kinds of bricks used, but as they are more or less of a fancy description, and as, also, the preceding include the whole of the standard bricks, it is not necessary here to refer further to them.

Of the materials used in mortar, the first, and, perhaps, the most important is lime, all varieties of which are very similar in their action. One of the most common is the gray-stone lime, large quantities of which are used in England. One of the most powerful materials is the blue-lias lime, which possesses the advantage of setting under water, and hence is sometimes termed hydraulic lime.

[1] As these definitions may be of use in interpreting the language of the many English text-books used in this country, we let them stand. — EDS.

It is principally found in Warwickshire and the west of England. Another lime is the white-chalk, which should really only be employed for plastering purposes. A lime which is very extensively employed at the present day, and is known as selenitic lime, originally known I believe, as Scott's cement. It requires very great care in manipulation, and nicety in the addition of the extraneous chemical ingredients, and, although when properly made, it is exceedingly effective, it is more often used for plastering than bricklaying, the workman in the latter craft not caring to take the necessary trouble.

I would here remind my readers that too much care cannot be taken with lime, as the air is almost as destructive as wet, and if properly stored, its setting power would be much greater in brickwork than it generally is. Lime, it should be borne in mind, when not in use should be covered up. Although, in former times, when mortar was mixed by a larry, and later, when the pug-mill took the place of the larry, the best use was not made of the lime, such is now, with the steam mortar-mill, not the case, as the lime, as well as the other ingredients, are all thoroughly well ground up, being reduced to the very finest grains, this method of manipulation far excelling any other. In these mills the lime is thoroughly incorporated with sand before it has had time, as in older processes it would have had, to expand, consequently the expansion, if the mortar is used at once as it should be, takes place in the brickwork, so the settlement or shrinkage to which brickwork in mortar is always more or less subject is obviated, and as less water is required by this method of preparation, there is less moisture to evaporate, and, as a matter of course, the mortar sets quicker, and in wet or frosty weather the work generally is less liable to damage. By this method also greater results are obtained with a much smaller quantity of lime; the screening is entirely dispensed with, as the mill will crush anything and everything in the way of core; thus all waste is utilized (too much so, in fact, by some unscrupulous builders) and in some instances sand is entirely dispensed with, not, however, I think, wisely. Where sand cannot be obtained and clay can, an excellent mortar is made by converting the clay into what is known as burnt ballast, this being afterwards pulverized in the mill with the necessary quantity of lime.

It will be understood from the foregoing that very much of the success in bricklaying depends upon the mortar, while this in its turn largely relies upon complete and thorough mixing and amalgamation. Before quitting the subject of mortar, I must say somewhat respecting sand, which is of equal importance with lime, for be the last-named ever so powerful, its power is minimized as the former is impure. Sand intended for mortar should be quite clean and of a sharp grit — river-sand being generally considered the best, pit-sand coming next. The sands employed for mortar are very numerous, but the builder must bear in mind that all those of a loamy description must be well and repeatedly washed before using, or it will not make good mortar.

Proceeding now with the actual process of brick-laying, I would impress upon the student that in the raising of brick walls, it is imperatively a necessity to have good, solid foundations. For all these trenches should be dug, and the ground tried with a rammer or a hammer in order to ascertain its general soundness. If the ground should appear to shake, it should be bored with a well-sinker's drill, in order to ascertain whether the looseness be local or general. Should the soil prove to be firm, the looser parts, if not very deep, must be dug up, until a bed of solid earth is reached. But should the ground not be very loose, it may sometimes be made sound and stable by ramming into it large blocks of stone, these being closely packed together and filled-in with smaller ones; but should the ground turn out to be very bad, especially if marshy, it must be piled and planked, when, in such cases, concrete will be found to be about the best material to employ. On rising ground, the foundation must be made in a series of steps. When the ground is loose over which it is intended to make windows, doors, etc., while the ground at the sides upon which the piers are to stand is firm, it is usual to turn inverted arches under such openings. This is a very necessary precaution in all instances where the depth of the wall below will permit of it, as the piers in settling will carry the arch with them, and, by compressing the ground, assist in securing a good structure. These arches should be turned with great exactness, and their height should be at the very least half their width. The beds of the piers ought to be as uniform as possible, for, although in some cases the bottom of the trench may be very firm, yet, if it vary at all in solidity, the piers will settle more in one place than in another, and thus cause a vertical fracture in the superstructure. If the solid portions of the trench are beneath the openings which it is intended to have, and the softer portions of the earth are where the piers are to be built, arches not inverted, must be suspended upon the firm ground, between them, and in such a case as this, great attention must be paid to the insisting pier, whether it cover the arch or not, because if the middle of the pier rest over the middle of the summit of the arch, the narrower the pier is, the greater should be the curvature of the arch at its apex. In the case of suspended arches, the intrados of the arch ought to be quite clear in order that the arch may have its full effect. In this case, also, the ground upon which the piers are erected should be of equal firmness, as otherwise the building is liable to be injured through unequal settling, which is far more injurious than when the ground, from being uniformly of a soft and sinking nature, permits of the piers descending equally, in which case the structure sinks as a whole, and no damage results.

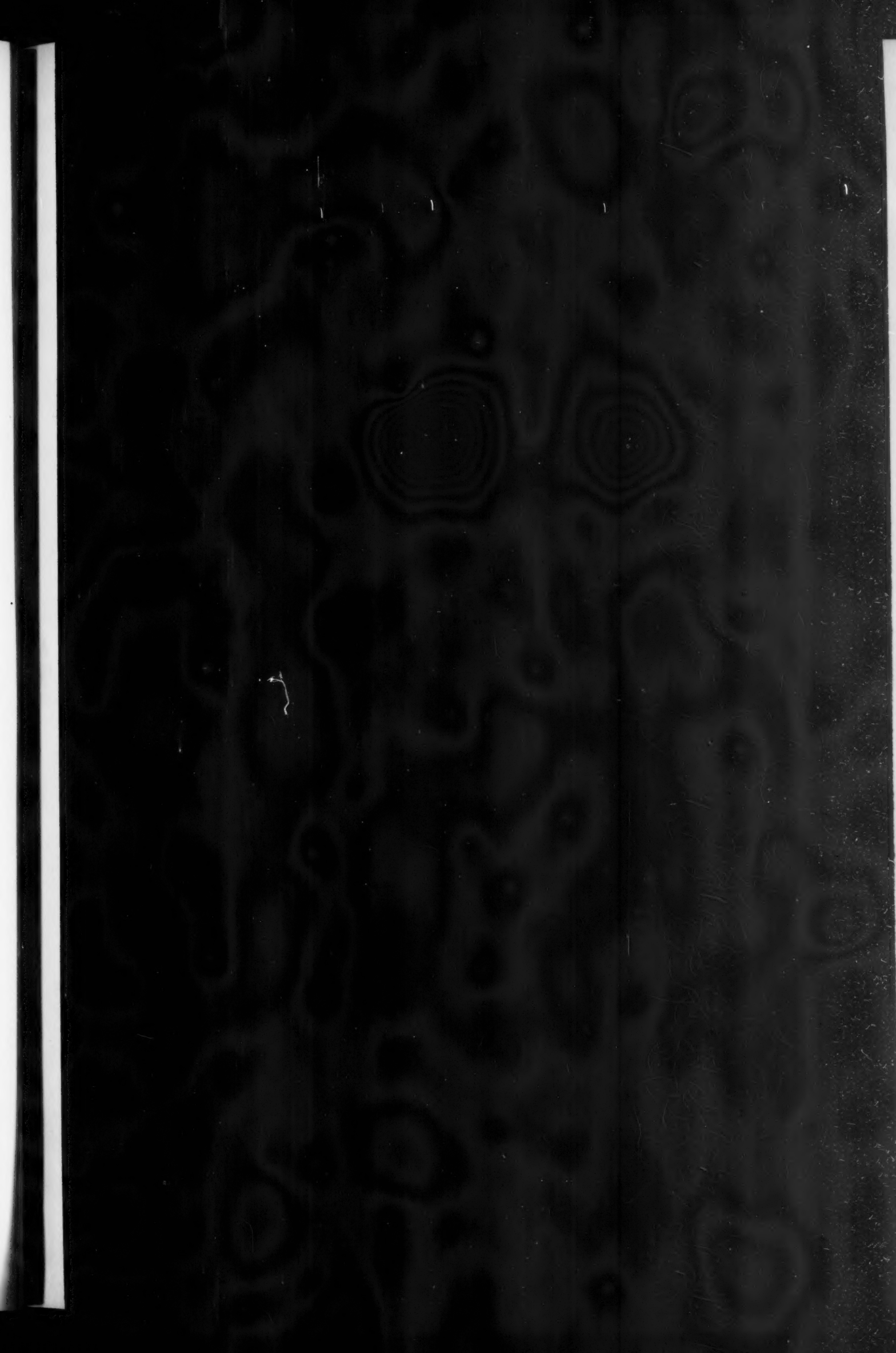
Passing from piers, I come to foundations, in ramming which, the stones employed should be previously chopped or hammered up, and then laid of a breadth proportionate to the weight which it is intended to put upon them, and finally rammed close together by means of a heavy rammer. As a general rule the lower layer of stones may project for a foot on each side of the wall intended to be raised, and on this bed another course may be placed, so as to bring the upper bed of stone upon a general level with that of the trench, which should project about eight inches on each side of the wall, each course receding four inches. The joints of every upper course must fall as nearly as possible on the middle of the stones in the course immediately beneath it — this being a rule that should be invariably followed in all kinds of walling, the object being to obtain the greatest lap one upon the other. The strength of all brickwork depends upon the manner in which the bricks are laid, the practice in England being generally confined to old English bond and Flemish bond. In the former a row of bricks laid lengthwise on the length of the wall is crossed by a row with its breadth in this length, and so on alternately. The courses in which the lengths of the bricks are disposed through the length of the wall are known as stretching-courses, and the bricks as stretchers. The courses in which the lengths of the bricks run in the thickness of the walls are known as heading-courses, and the bricks as headers. The Flemish bond, consists in placing a header and stretcher alternately in the same course, and though the effect is more pleasing, the mode is not so durable. In a nine-inch wall, it is usual, in the English bond, to prevent two vertical joints from running over each other at the end of the first stretcher from the corner, to place the return corner stretcher, which becomes a header in the face that the stretcher is in below, and occupies half its length; a quarter-brick is placed on the inside, so that the two extend to six three-fourth inches, leaving a lap of two one-fourth inches (to make up the nine inches) for the next header, which lies with its middle upon the middle of the header below, and thus forms a continuation of the bond. The three-quarter bat thus introduced is known as a "closer." A similar effect can be produced by introducing a three-quarter bat at the corner of the stretching-course, and then the corner-header being laid over it, a lap of two one-fourth inches will be left at end of the stretchers below for the next header, which being laid, the joint below the stretchers will coincide with its middle and thus form the bond. In a fourteen-inch or brick-and-a-half wall, the stretching-course upon one side is laid so that the middle of the breadth of the bricks upon the opposite side falls alternately upon the middle of the stretchers and upon the joints between the stretchers.

In a two-brick wall, every alternate header in the heading-course is only half-a-brick thick on both sides, which breaks the joints in the core of the wall. In a nine-inch wall built according to Flemish bond, two stretchers lie between two headers, the length of the headers and the breadth of the stretchers extending to the whole thickness of the wall. In Flemish-bond walls there is a frequent splitting, and to prevent it laths or slips of hoop-iron are at times laid in the horizontal joints between the two courses. At other times diagonal courses of bricks are laid at certain heights from each other. Attempts have also been made to unite a complete bond with Flemish facings for the sake of the improved appearance which is thus gained, but it is not strong or at all satisfactory. The following rules for forming English bond, as given by that well-known authority, Mr. Nicholson, cannot be bettered: First, each course is to be formed of headers and stretchers alternately; second, every brick in the same course must be laid in the same direction; but in no instance is a brick to be placed with its whole length alongside of another; but to be so situated that the end of one may reach to the middle of the others which lie contiguous to it, excepting the outside of the stretching course, where three-quarter bricks necessarily occur at the ends, to prevent a continued upright joint in the face-work; third, a wall which crosses at a right angle to another will have all the bricks of the same level course in the same parallel direction, which completely bonds the angles.

When building a wall, the beginner should remember that the bricks should incline slightly towards the middle of the wall, in that one-half may act as a shore to the other. Walls are also very much strengthened by layers of hoop-iron being inserted between the courses. In winter-time all brickwork should be covered with straw and wood, to protect it from the alternate effects of rain and frost.

When a wall is finished, the joints of the bricks on the face, are sometimes filled up with mortar so as to present a neat and uniform appearance. This is known as pointing, of which there are two kinds, in both of which the mortar is well raked out, and filled up again with blue mortar, though in one kind, known as flat-joint pointing, the courses are simply marked with the edge of a trowel. If, beside this, plaster be inserted in the joints with a regular projection, and neatly pared to a parallel breadth, this is known as tuck-joint pointing.

Groined arches are sometimes made of brick, being generally raised on centres formed of carpentry work. The turning of a simple arch on a centre only requires care in the keeping of the courses as close as possible, and to avoid the use of much mortar on the inner parts of the joints. The great difficulty in executing a brick groin arises from the peculiar method of making a proper bond at the intersection of the two circles as they gradually rise to the crown, where they form an exact point. In the meeting or intersecting of these angles, the inner rib should be perfectly straight



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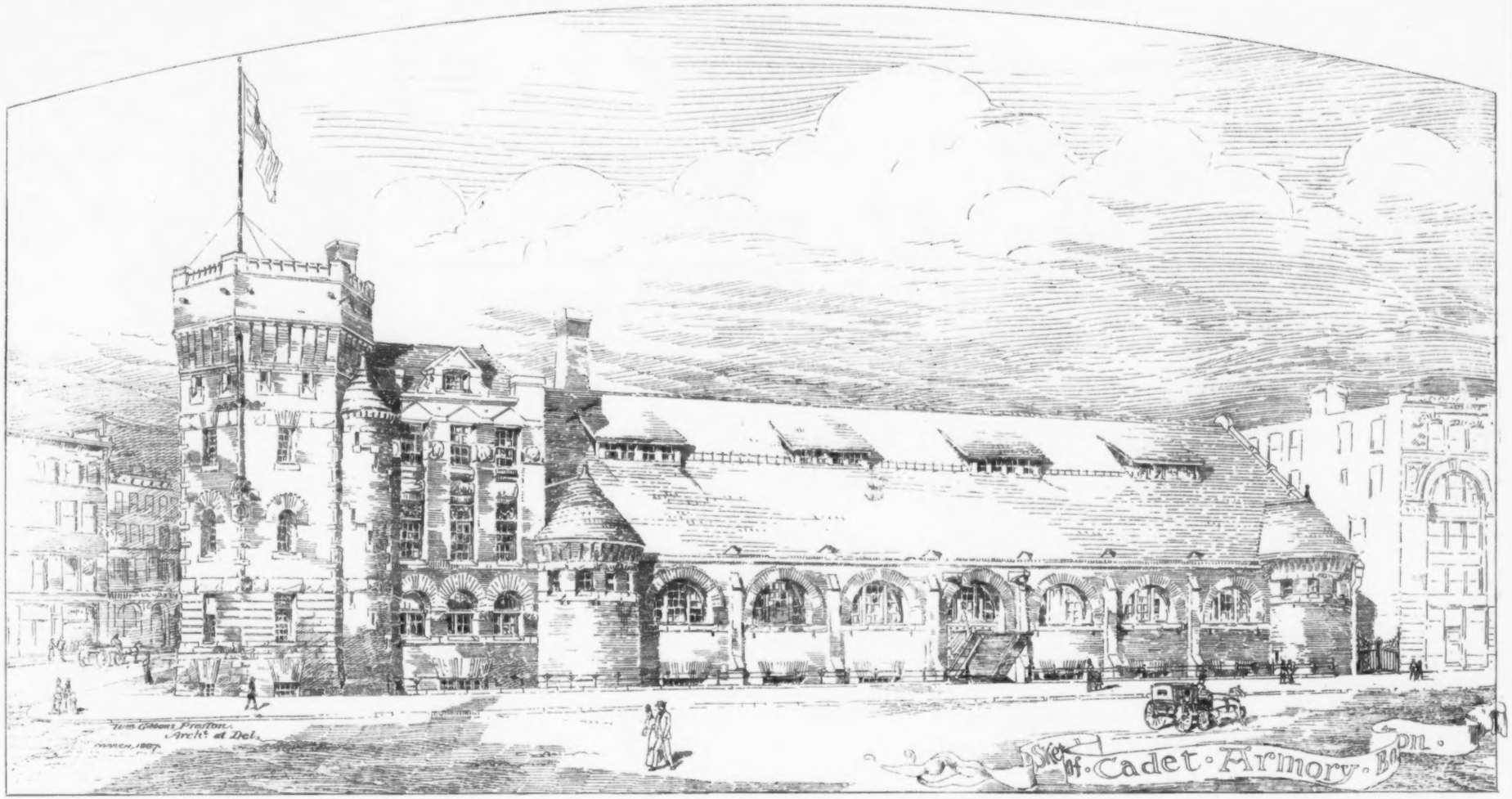

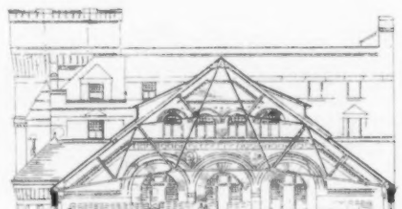

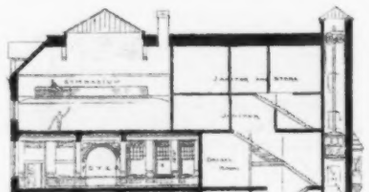

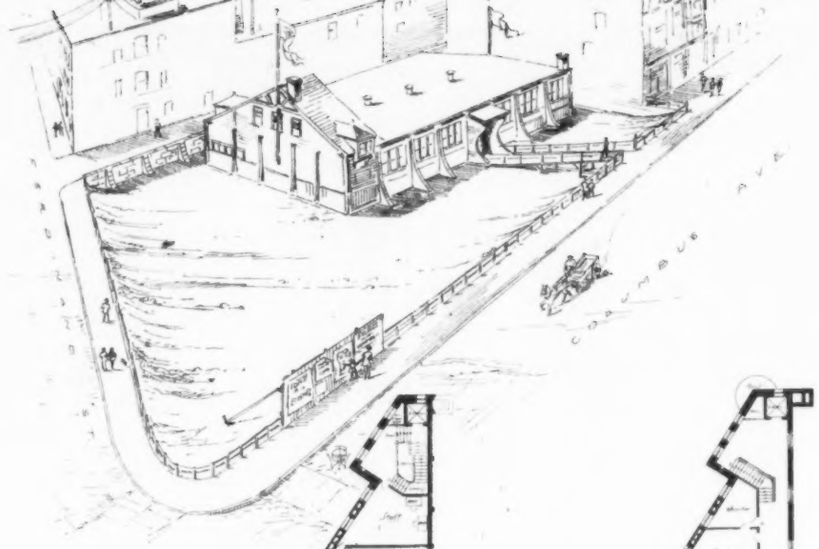

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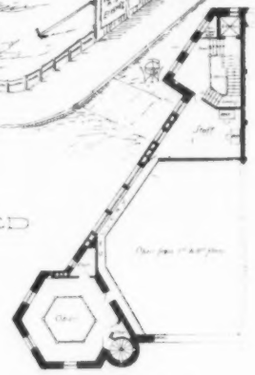
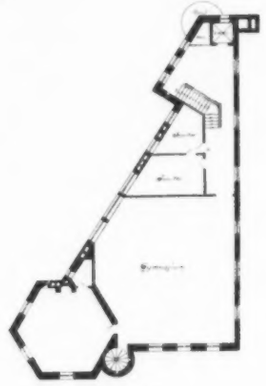
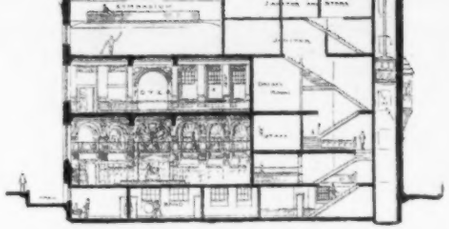


MEZZANINE FLOOR

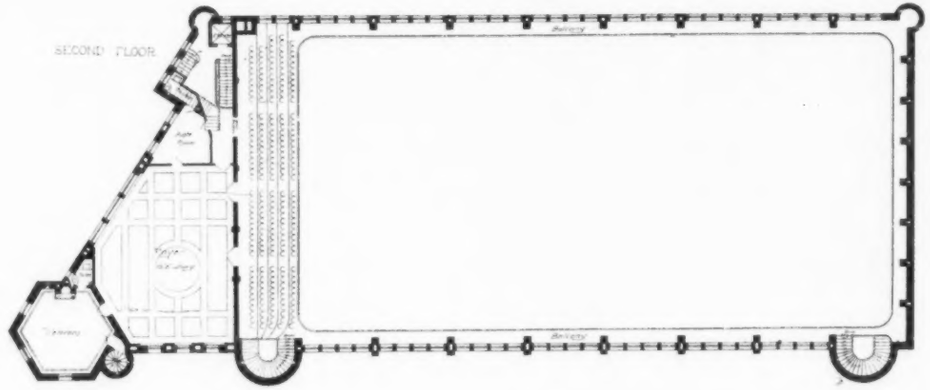


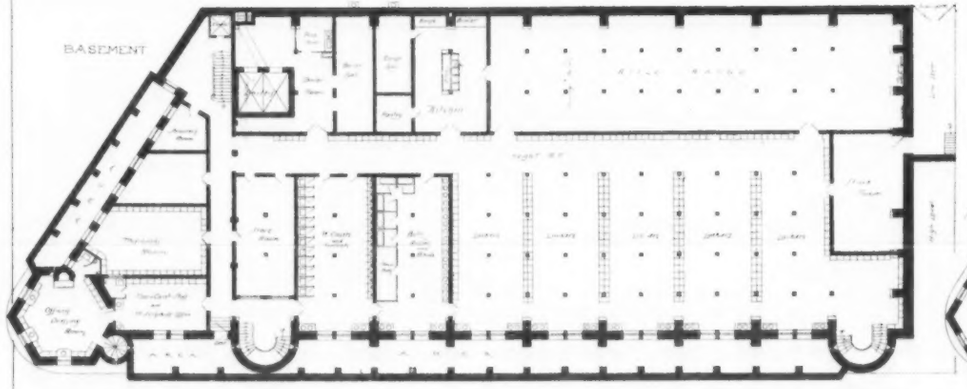
THIRD FLOOR

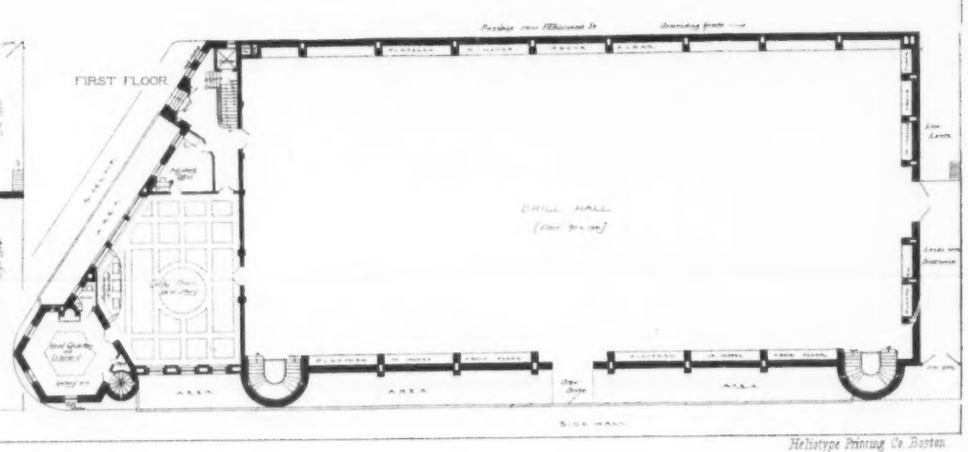
Section through Drill Hall



Section through Large Room
Foyer and Stairs







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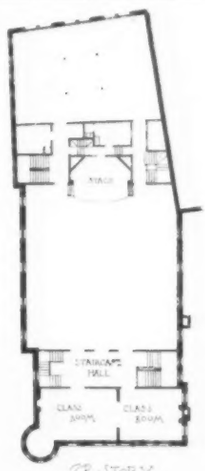

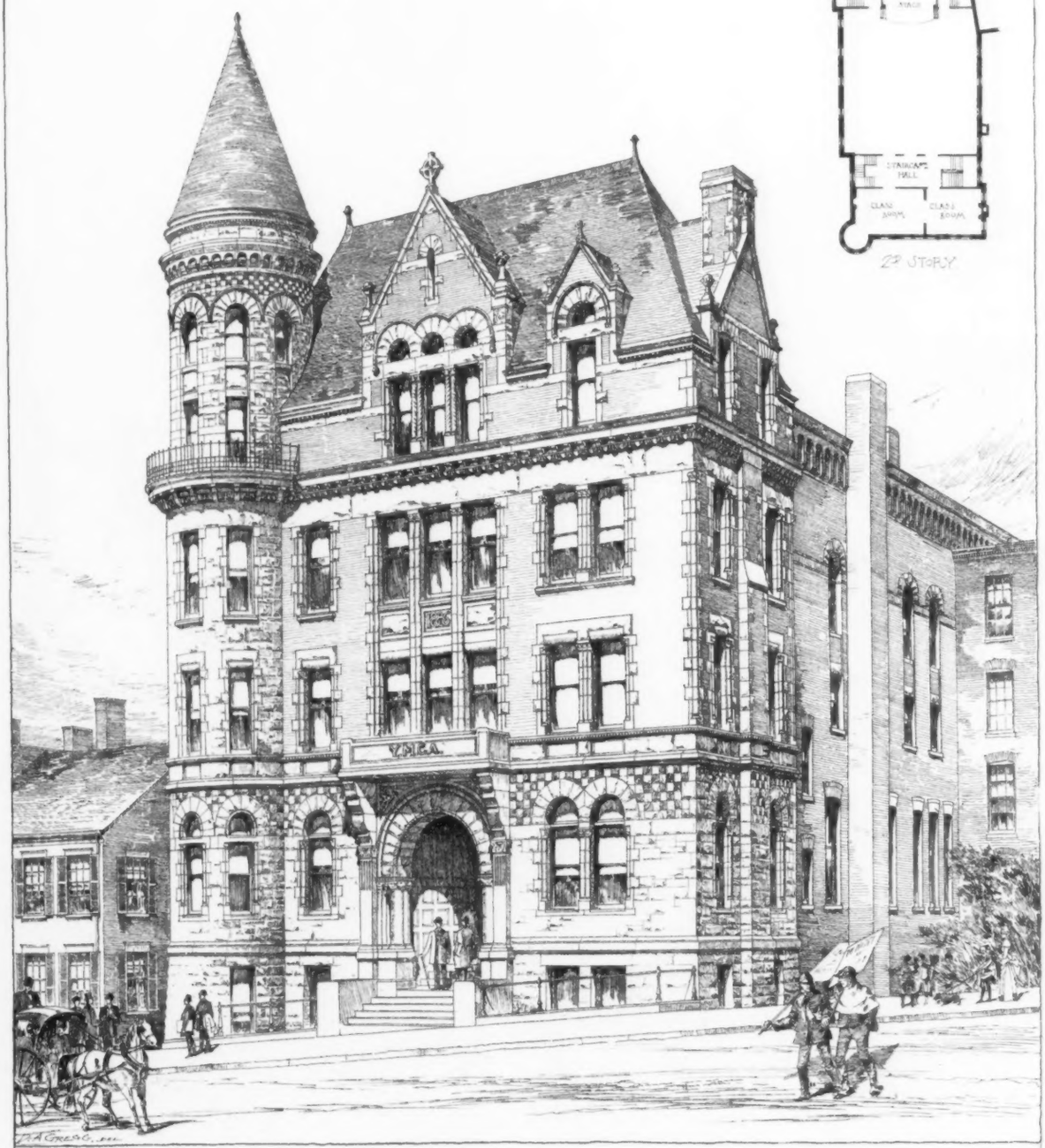

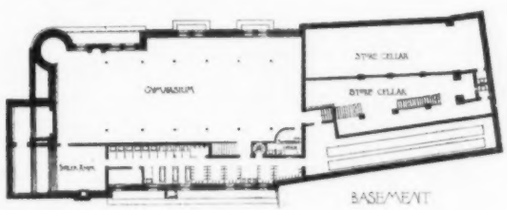

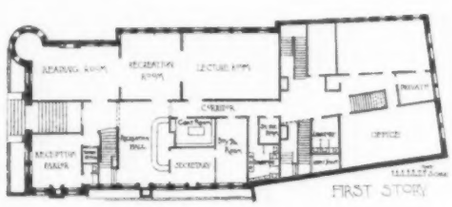

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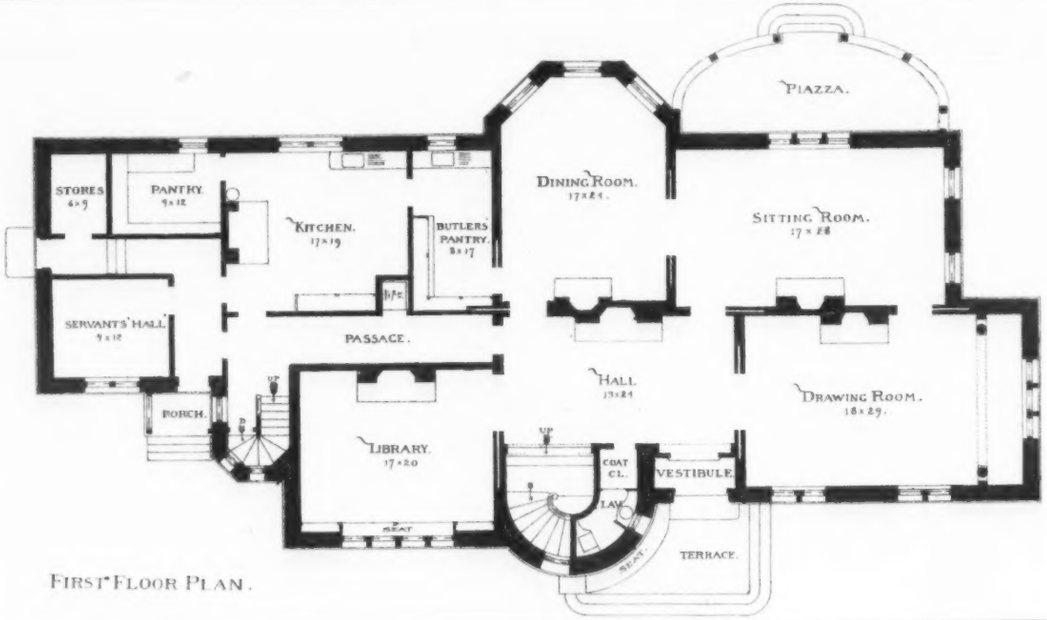
VIEW FROM LAWN.

Wm A.B. Del.

VIEW FROM COURT-YARD.



FIRST FLOOR PLAN.

HOUSE IN DETROIT, MICH.

WILLIAM A. BATES, ARCH'T.

149 BROADWAY, NEW YORK.

Heliotype Printing Co. Boston.

and perpendicular to a diagonal line drawn on a plan. After the centres are set, the application of the brick to the angle will show in what direction it is to be cut. The sides are turned as in common cylindrical vaults. The student will find that a variety of ornamental brick cornices can be formed by cutting and changing the positions of the bricks employed, while others can be formed by chamfering only. Perhaps the most difficult portion of bricklayers' work is the constructing of niches. the difficulty arising from the thinness to which the brick must be reduced at the inner circle, as they cannot extend beyond the thickness of one brick at the crown or top, it being customary to make all the courses standing, whereby much neatness is obtained. With this my remarks upon bricks and bricklaying must terminate. W. N. BROWN.

[To be continued.]

ILLUSTRATIONS

[Contributors are requested to send with their drawings full and adequate descriptions of the buildings, including a statement of cost.]

A DINING-ROOM INTERIOR. MR. CHARLES A. GIFFORD, ARCHITECT, NEWARK, N. J.

[Gelatine Print, issued only with the Imperial Edition.]

ARMORY FOR THE FIRST CORPS OF CADETS, M. V. M., BOSTON, MASS. MR. WM. GIBBONS PRESTON, ARCHITECT.

THE Cadet Armory is located on a lot about 112′ x 250′ on Columbus Avenue and Ferdinand Street. Passage-ways bound the other two sides of the building, so that it is detached and isolated. The building is to be so constructed that by raising the drawbridge and closing heavy iron shutters on all windows, it becomes practically a fortress, where the corps can, if necessary, resist a protracted attack by a mob, or, in time of need, provide shelter and refuge for helpless citizens.

The building will be of brick and brownstone, and will comprise two portions, the drill-hall, 100′ x 200′, and the administration department, or "head house" having a frontage of fifty feet on Columbus Avenue, and one hundred and twenty feet on Ferdinand Street.

A severe and simple castellated style has been adopted in the design, modified, as must all styles be, to meet the complex uses of a modern structure. The drill-hall is expressed by its low, long roof. It is lighted by windows high up in the walls, protected by musket-proof iron shutters. The roof is supported by iron trusses and the nterior walls are to be of buff glazed-bricks. Beneath the drill-hall are the company dressing-rooms, bath-rooms, heating-apparatus, armory, rifle-ranges, store-rooms, etc. The stairways connecting the gallery which surrounds the drill-hall with the main floor and the basement are located in the semi-circular bays — and they are also provided with loop-holes, properly placed for flank defence of the area, ten feet in width, giving light and air to the basement. The "head house" is marked by an hexagonal tower at its angle. In the upper part of the tower will be located a great water-tank, and from its roof the flag-signal corps can communicate with the State House or other elevated buildings. In the "head house" are the corps-room, about 40′ x 40′, headquarters, library, Veteran Association's rooms, gymnasium, store-rooms, janitor, etc.

An elevator gives access to all stories. The main stairway is reached from the Ferdinand-Street side, and a supplementary, private stair is in the small circular bay, adjoining the tower. Every precaution will be taken against injury by fire, and the intention is to make the armory a model of its kind.

A portion of the foundations is already in place, and the work will be pushed forward as rapidly as circumstances warrant.

OFFICE OF THE NEW YORK LIFE INSURANCE CO., ST. PAUL, MINN. MESSRS. HODGSON & STEM, ARCHITECTS, ST. PAUL, MINN.

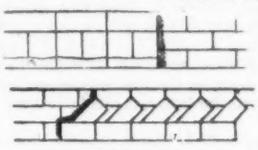
THE structure is entirely fireproof, and the intention is to use Georgia marble for the first three floors, and St. Louis fire-bricks for the remainder, trimmed in terra-cotta of the same character as the bricks.

BUILDING OF THE YOUNG MEN'S CHRISTIAN ASSOCIATION, WORCESTER, MASS. MESSRS. FULLER & DELANO, ARCHITECTS, WORCESTER, MASS.

HOUSE AT DETROIT, MICH. MR. W. A. BATES, ARCHITECT, NEW YORK, N. Y.

TO MEND A BROKEN STEAM-PIPE.— The *Mechanical News* describes an ingenious means of repairing a break in a steam-pipe: "The break is bound with wood strips laid close together, and well 'served' around with stout cord or rope. Endwise separation is prevented by more rope crossing the break diagonally, and tied so as to draw the broken parts together. When the wood and the cord get wet with the steam the joint is even tighter than before, for the wood swells and the cords shorten."

SAFE BUILDING.—XVI.[1]



Figs. 78 and 79.

Brick facings.

BRICK facings, as laid up in this country, usually consist of all stretchers. Every fifth or sixth course is bonded into the backing, either by splitting the brick in two, as shown in Figure 78, and using short headers behind it, or by breaking off the rear corners, as shown in Figure 79, and using diagonally-laid bond-brick.

The latter course is the better, but there is no strength in either; particularly as, as a rule, the front brick are so much softer and weaker than those in the backing.

The English bond, in which a course of headers alternates with a course of stretchers, is much to be preferred; or, better yet, the Flemish bond, where in each course a header alternates with a stretcher. Of course, in both English and Flemish bond, if the front brick are thinner than the bricks used in the backing, larger and more unsightly joints will be necessary in front.

Regular work the best.

It is best, as a rule, not to count on the front work for strength. We frequently see masons laying up brick walls by first laying a single course of headers or stretchers on the outside of the wall, and then one on the inside, and then filling the balance of wall with bats and all kind of rubbish. This makes a very poor wall. The specification should provide that no bats or broken brick will be allowed, leaving it to the architect's discretion to stop their use, if it is being overdone; of course, some few will have to be used. But, after all, the best wall is that one which is built the most regularly and with the most frequent bonds, and no architect should be talked out of good, regular work, as being *too theoretical*, by so-called "practical" men. The necessity for regularity and bond is easily illustrated by taking a lot of bricks of different sizes, or even toy blocks, and attempting to pile them up without regularity; or, even if piled regularly, without bond. It will quickly be seen that the most regular and most frequently-bonded pile will go the highest. By "bond" is meant alternating headers and stretchers with regularity, and so as to cover and break joints.

Use of bond-stones.

The use of "bond-stones" *at intervals only* is bad; they should be carried through the whole surface (width and length) of wall and be of even thickness, or else be omitted. Using bond-stones in one place only tends to concentrate the compression on one part of the wall. Thus, bond-stones built under each other at regular intervals, as shown in Figure 80, are bad, as they give the pressure no chance to spread, but keep concentrating it back onto the part of wall between the vertical lines A and B, whereas, in Figure 81, the pressure is allowed to spread gradually over a larger area of the wall. Where, however, a heavy girder, column or other weight comes on a wall, it is distributed by means of a large block, generally granite or stone, or sometimes by a large iron plate.

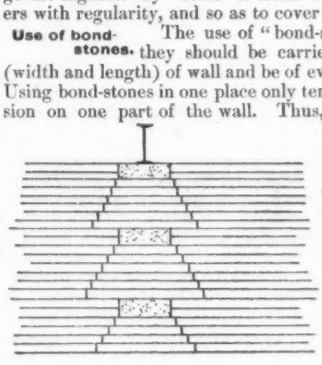


Fig. 80.

The block or plate should have sufficient area not to crush the brickwork directly under it. Where girder-ends are built into walls, it is also desirable to build a block *over* the girder-end as well as under the same. The upper block prevents any part of the wall from resting on the girder or being affected by its shrinkage, if of wood; if the girder is of iron, the upper block will wedge in the girder-end more firmly, and the girder will be able to carry more load. See page 63, No. 554 (Table VII).

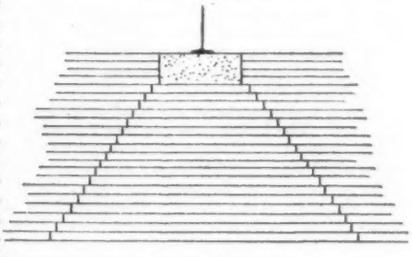


Fig. 81.

Metal anchors.

Anchors for girders and beams are usually made of iron and of such shape as to allow the girder or beam to fall out in case of fire. Anchors made of iron are not objectionable in inner walls, or where not exposed to dampness; all iron should be thoroughly painted, however, with red lead or metallic paint. Before painting, all rust should be scraped off. Don't believe the "practical" man who says the paint will stick better if you leave the rust on the iron; it will stick better to the rust, no doubt, but not to the iron. For outside work all iron should be galvanized; but it is better to use copper for anchors, dowels, clamps, etc. All copings should be clamped together, the clamps being counter-sunk. Slanting-work and tracery should be dowelled together. Where iron is let into stones, and run with lead or sulphur, the iron is apt to swell with

[1] Continued from No. 593, page 226.

rust or heat and burst the stone. Dampness in walls is one of the worst dangers, both on account of frost and decay.

Drip-moulds. All exterior mouldings and sills should be projected and have "drip-moulds" cut underneath, to cause the water to drop or drip; this will prevent considerable dampness and keep the outside surface of the wall from becoming dirty, as the dust lodging on top of mouldings discolors the rain-water, and the latter, instead of streaking down the wall, will drop off.

Hollow walls. Walls are frequently built hollow to prevent dampness, but this raises many objections. Shall the inner or outer wall be the thicker? If the outer wall, then all beams, etc., have to be that much longer, so as to rest on the stronger part; they are liable to transfer dampness, and then, too, the thicker, and, consequently, greater, part of wall is exposed to dampness. If the inner wall is thicker, the construction, so far as beams, etc., are concerned, no doubt is better, but the outer part is apt to be destroyed by the frost. Then at windows and doorways both must be connected, and dampness is apt to get through. It is well to ventilate the air-space between walls, at the bottom from inside and at the top from outside. The bottom of spaces should be drained. Tops of arches, or lintels over openings, should be cemented and asphalted (in the air-space), to shed any dampness settling on them.

The outer and inner walls should be frequently anchored together. Iron anchors galvanized, or copper anchors are best; they should have a half-twist, as shown, to prevent water running along them.

Fig. 82.

Care must be taken to keep hollow walls free from hanging mortar, which will communicate moisture from one wall to the other.

But hollow walls are not nearly so good as solid walls with porous terra-cotta furrings.

Where walls are coped with stone, there should be damp-courses of slate or asphalt under same, and the back side should be flashed, to prevent dampness descending. If gutters are cut in stone cornices, they should be lined with metal, preferably of copper, the outer edge being let into a raggle and run in with lead.

Underpinning. When a wall, already built, has to have its foundations carried down lower, it is called "underpinning the wall." Holes are made through the wall at intervals and through these (at right angles to the wall) are placed the "needles," that is, heavy timbers, which carry the weight of the wall. Where the needle comes in contact with the wall, small cross-beams are laid on its upper side, and wedged and filled with mortar, to get a larger and more even bearing against the wall. At the inner and outer ends of the needles heavy upright timbers are placed underneath, running down to the new, lower level. The foot or ground bearing of these timbers is formed by heavy planks crossing each other, to spread the weight over more ground; wedges are driven under the feet of the uprights, till the ends of the needle are forced up, and the centre of the needle shows a decided downward curve of deflection, indicating that the weight of wall is on the needle. Frequently jack-screws are used in place of wedges, to get the weight onto the uprights. As soon as the needles carry the weight of wall, the intermediate portions of wall are torn out and the excavating to the lower level begins. If the soil is loose, sheath-piling must be resorted to on each side of wall. Frequently the feet of the uprights are "cribbed," that is, sheath-piled all around, to hold the ground under them together and keep it from compressing. The new wall is built up from the lower level between and around the needles. On top of the new wall two layers of dressed-stone are placed filling up between the old and new work. Between these stones iron wedges are driven in opposite pairs, one from the inside and one from the outside. These wedges must be evenly driven from both sides or the wall might tip. These wedges are driven until the weight of the wall is on them and off the needles.

This is readily seen, for the needles straighten out when relieved of the load. The jack-screws are now lowered or the wedges under the uprights eased up; the uprights taken away, needles removed, and the holes filled up. Underpinning operations must be slowly and carefully performed, as they are very risky. If there is any danger of a wall tipping during the operation, grooves are cut into the wall and "shores" or braces placed against it. The feet of the shores rest on cross-planks, same as uprights, and are wedged up to get a secure bearing of the top of the shore against the wall. Where the outside of a wall cannot be got at, "spring needles" are used from the inside. That is, the one end of the needle acts as a lever and supports the wall, while the other, inner end, is chained and anchored down to prevent its tipping up.

Strength of bricks. The strength of a wall depends, of course, largely on the material used. A good, hard-burned brick, well laid in cement-mortar, makes a very strong wall. To tell a good brick, first examine the color; if it is very light, an orange-red, the brick is apt to be soft. If the brick is easily carved with a knife, it is soft. If it can be crushed to powder easily, it is soft. If two bricks are struck together sharply, and the sound is dull, the bricks are poor; if the sound is clear, ringing, metallic, the bricks are good and hard. If a brick shows a neat fracture, it is a good sign; a ragged fracture is generally a poor sign. The fracture also shows the evenness of the burning and fineness of the material. A brick that chips and cannot be cut easily is a good brick. The darker the brick, the harder burned. This, of course, does not hold good for artificially-colored bricks. The straighter and more regular the brick, the softer it is (as a rule), as hard-burning is apt to warp a brick.

What has been said of the strength of bricks holds good of terra-cotta. The latter should be designed to be of same thickness, if possible, in all parts, and any hollows caused thereby must be filled-in solid. It is best to fill-in the hollows with bricks and mortar several days in advance, and let the filling set, so as to be sure it will not swell up afterwards and burst the terra-cotta.

Strength of stones. To judge of the strength and durability of stones is a more difficult matter. If the stone be fractured, and presents, under a magnifying glass, a bright, clear, sharp surface, it is not likely to crumble from decay; if the surface is dull-appearing and looks earthy, it is likely to decay. Of course, samples can be tested for their crushing and tensile strengths, etc. And we can tell somewhat of the weathering qualities by observing similar stones in old buildings; much, however, depends whether the stones come from the same part of the quarry. Another test is to weigh different samples, when dry; immerse them in water for a given period, say, twenty-four hours, then weigh them again, and the sample absorbing the least amount of water (in proportion to its original weight) is, of course, the best stone.

Another test is to soak the stone in water for two or three days and put it out to freeze; if it does not chip or crack, it will probably weather well. Chemical tests are made sometimes, such as using sulphuric acid, to detect the presence of lime and magnesia; or, soaking the stones in a concentrated boiling solution of sulphate of soda; the stones are then exposed to the air, when the solution crystalizes in the pores and chips off particles of the stone, acting similarly to frost. The stones are weighed before and after the tests, the one showing the least proportional loss of weight being, of course, the better.

If stones are laid on their natural beds, however, little need be feared of the result, if the stone seems at all serviceable. The main dangers to walls are from wet and frost. Very heavy and oft-repeated vibrations may sometimes shake the mortar-joints, but this need not be seriously feared, in most cases; machinery may often cause sufficient vibrations to be unpleasant, or even to endanger wood or iron work, but hardly well-built masonry. Of course, the higher a building is, the greater will be the amount of vibrations and their strength. For this reason it is advisable to place the heaviest machinery on the lowest (ground) floor. The beds of such machinery should be as far as possible from any foundations of walls, columns,

Machinery foundations. etc., and the beds should be independent and isolated from all other masonry. Malo, in *Le Génie Civil*, recommends the use of asphalt for machinery-foundations, as they take up the vibrations and noise, and are as solid as masonry, if properly built. His claim seems well founded, and has been demonstrated practically; the asphalt foundation not only preventing vibrations but stopping the sound. A wooden form is made, covered inside with well-greased paper; into this are placed slightly-conical shaped wooden bars and boxes, also covered with well-greased paper, which are secured in the places to be occupied by the bolts and bolt-heads, and arranged for easy withdrawal. A layer of melted asphalt a few inches thick is then poured into the mould; over this are dumped heated, perfectly clean, sharp, broken stones and pebbles, rammed solid, the pebbles filling all interstices; then more asphalt is poured in, then another layer of stones and pebbles, etc. It is claimed that this foundation becomes so solid that it will not yield enough to disarrange the smooth running of any machinery, while its slightly-elastic mortar, besides avoiding vibrations and noise, prolongs very much the durability and usefulness of the

Glossary of Symbols.—The following letters, *in all cases*, will be found to express the same meaning, *unless distinctly otherwise stated*, viz.:—

a = *area*, in square inches.
b = *breadth*, in inches.
c = constant for *ultimate resistance to compression*, in pounds, per square inch.
d = *depth*, in inches.
e = constant for *modulus of elasticity*, in pounds-inch, that is, pounds per square inch.
f = *factor-of-safety*.
g = constant for *ultimate resistance to shearing*, per square inch, across the grain.
g_1 = constant for *ultimate resistance to shearing*, per square inch, lengthwise of the grain.
h = *height*, in inches.
i = *moment of inertia*, in inches. [See Table I.]
k = *ultimate modulus of rupture*, in pounds, per square inch.
l = *length*, in inches.
m = *moment or bending moment*, in pounds-inch.
n = *constant* in Rankine's formula for compression of long pillars. [See Table I.]
o = the *centre*.
p = the *amount* of the *left-hand re-action* (or support) of beams, in pounds.
q = the *amount* of the *right-hand re-action* (or support) of beams, in pounds.
r = *moment of resistance*, in inches. [See Table I.]
s = *strain*, in pounds.
t = constant for *ultimate resistance to tension*, in pounds, per square inch.
u = *uniform load*, in pounds.
v = *stress*, in pounds.
w = *load at centre*, in pounds.
x, y and z signify *unknown quantities*, either in pounds or inches.
δ = *total deflection*, in inches.
ρ^2 = *square of the radius of gyration*, in inches. [See Table I.]
$\mathfrak{d}$ = *diameter*, in inches.
$\mathfrak{r}$ = *radius*, in inches.
π = 3.14159, or, say, 3.1-7 signifies the *ratio of the circumference and diameter of a circle*.

If there are more than one of each kind, the second, third, etc., are indicated with the Roman numerals, as, for instance, a, a_{II}, a_{III}, etc., or b, b_{II}, b_{III}, b_{IV}, etc.

In taking moments, or bending moments, strains, stresses, etc., to signify at what point they are taken, the letter signifying that point is added, as, for instance:—

m = moment or bending moment at *centre*.
m_A = " " " *point A*.
m_B = " " " *point B*.
m_X = " " " *point X*.
s = strain at *centre*.
s_B = " *point B*.
s_X = " *point X*.
v = stress at *centre*.
v_D = " *point D*.
v_X = " *point X*.
w = load at *centre*.
w_A = " *point A*.

machinery. Two dangers must be guarded against, viz., the direct contact of oil or heat with the asphalt. Stationary drip-pans guard against the former, while a layer of rubber, wood, cement, or other non-conductive material would accomplish the latter object. Where noise from machinery is to be avoided, a layer about one inch thick, of hard rubber or soft wood, should be placed immediately under the engine-plate. If this layer were bedded in asphalt the precaution would be still more effective.

Quality of asphalts. In all cases where asphalt is used, that with the least proportion of bitumen should be preferred.

Seyssell asphalt, which comes from France, is undoubtedly the best, and next to this comes the Swiss or Neuchâtel asphalt.

Trinidad asphalt, which is much used in this country, is much inferior, being softer and containing a larger proportion of bitumen or tar — a great disadvantage in many cases.

Openings over each other. In all walls try to get all openings immediately over each other. A rule of every architect should be, to make an elevation of *every* interior wall, as well as of the exterior walls, to see that openings come over each other.

Tower walls. It is foolish to make chimneys or tower-walls unnecessarily thick (and heavy), as they brace and tie themselves together at each corner, and, consequently, are much stronger than ordinary walls. Tower-walls, however, often require thickening all the way down, to allow for deep splays and jambs at the belfry openings. The chief danger in towers is at the piers on main floor, which are frequently whittled down to dangerous proportions, to make large door openings. In tall towers and chimneys the leverage from wind must be carefully considered.

Considering the importance of ascertaining the exact strength of walls, it is remarkable that so little attention has been paid to the subject by writers and experimenters. The only known rule to the writer is Rondelet's graphical rule, which is as follows:

Rondelet's rule. If A B (Figure 83) be the height of a wall, B C the length of wall without buttress or cross-wall (A B C being a right angle), then draw A C; make A D = to either $\frac{1}{8}$ or $\frac{1}{10}$ or $\frac{1}{12}$ of A B, according to the nature of wall and building it is intended for ($\frac{1}{12}$ for dwellings, $\frac{1}{10}$ for churches and fireproof buildings, and $\frac{1}{8}$ for warehouses); then make A E = A D, and draw E F parallel to A B; then is B F the required thickness of wall. The rule, however, in many cases, gives an absurd result. Gwilt's "*Encyclopædia of Architecture*" gives this rule, and many additional rules, for its modification. There are so many of them, and they are so complex, however, as to be utterly useless in practice. Most cities have the thickness of walls regulated by law, but, as a rule, these thicknesses give the minimum strength that will do, and where they do not regulate the amount and size of flues and openings, frequently allow dangerously-weak spots in the wall.

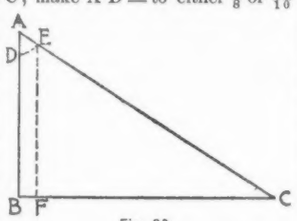


Fig. 83.

Formula for masonry. The writer prefers to use a formula, which he has constructed and based on Rankine's formula for long pillars, see Formula (3), and which allows for every condition of height, load, and shape and quality of masonry. In the case of piers, columns, towers or chimneys, whether square, round, rectangular, solid or hollow, the Formula (3) can be used, just as there given, inserting for ρ^2 its value, as given in the last column of Table I, using, of course, the numbered section corresponding to the cross-section of the pier, column or towers. By taking cross-sections at different points of the height, and using for l the height in inches from each such cross-section to the top, we will readily find how much to offset the wall. Care must be taken, where there are openings, to be sure to get the piers heavy enough to carry the additional load; the extra allowance for piers should be gotten by calculating the pier first as an isolated pier of the height of opening, and then by taking one of our cross-sections of the whole tower or chimney at the level where the openings are, and using whichever result required the greater strength.

Strength of piers, chimneys and towers. As it would be awkward to use the height l in inches, we can modify the formula to use the height L in feet. Further, we know the value of n for brickwork, from Table II, and can insert this, too; we should then have:

For brick or rubble piers, chimneys and towers, of whatever shape:

$$w = \frac{a.\left(\frac{c}{f}\right)}{1 + 0{,}475.\left(\frac{L^2}{\rho^2}\right)} \qquad (59)$$

Where w = the *safe total* load on pier, chimney or tower in pounds.

Where a = the area of cross-section of pier, etc., in square inches, at any point of height.

Where L = the height, in feet, from said point to top of masonry.

Where $\left(\frac{c}{f}\right)$ = the safe resistance to crushing, per square inch, as given in Table V.

Where ρ^2 = the square of the radius of gyration, of the cross-section, in inches, as given in Table I.

If it is preferred to use *feet and tons* (2000 lbs. each) we should have

$$W = \frac{A.\left(\frac{c}{f}\right)}{14 + 0{,}046.\left(\frac{L^2}{P^2}\right)} \qquad (60)$$

Where w = the *safe total* load on masonry, in tons, of 2000 lbs. each.

Where a = the area of cross-section of masonry, at any point of height, in square feet.

Where l = the height, in feet, from said point to top.

Where $\left(\frac{c}{f}\right)$ = the safe resistance to crushing, in lbs., per square inch, as given in Table V.

Where p^2 = the square of the radius of gyration, as given in last column of Table I, — *but all dimensions to be taken in feet.*

To obtain the load on masonry, include weight of all masonry, floors, roofs, etc., above the point and (if wind is not figured separately) add for wind 15 lbs. for each square foot of outside superficial area of *all* walls above the point.

Where towers, chimneys, or walls, etc., are isolated, that is not braced, and liable to be blown over-by wind, the wind-pressure must be looked into separately,

In regard to the use of $\left(\frac{c}{f}\right)$ the safe resistance, per square inch, of the material to crushing, it should be taken from Table V. So that for rubble-work we should use:

$$\left(\frac{c}{f}\right) = 100$$

And the same for poor quality brick, laid in lime mortar.

For fair brick in lime and cement (mixed) mortar, we should use:

$$\left(\frac{c}{f}\right) = 150$$

And for the best brickwork in cement mortar, we should use:

$$\left(\frac{c}{f}\right) = 200$$

If, however, a wall (or pier) is over 3 feet thick, and laid in good cement mortar, with the best hard-burned brick, and there are not many flues, etc., in the wall, we can safely use:

$$\left(\frac{c}{f}\right) = 250$$

If the wall (or pier) is over 3 feet thick, and there are no flues or openings, and the best brick and foreign Portland cements are used, it would be perfectly safe to use:

$$\left(\frac{c}{f}\right) = 300.$$

Example.

A tower 16 feet square outside, carries a steeple weighing, including wind-pressure, some 15 tons. The belfry openings, on each side, are central and virtually equal to openings 8 feet wide by 18 feet high each. There are 8 feet of solid wall over openings. What should be the thickness of belfry piers? The masonry is ordinary rubble-work.

Tower Walls. In the first place we will try Formula (60) giving strength of whole tower at base of belfry piers. The load will be: 4.(26.16 — 18.8 — 26.1⅔) = 892 superficial feet of masonry 20″ thick and weighing 250 lbs. per superficial foot = 223000 lbs. (see Figures 84 and 85): add to this spire and we have at foot of belfry piers:

Actual load = 253000 lbs. or = 126 tons.

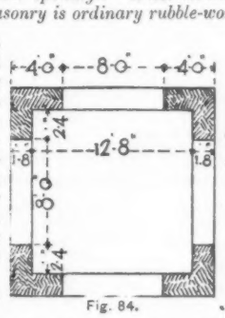


Fig. 84.

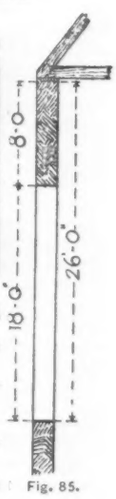


Fig. 85.

Now p^2 (the square of the radius of gyration) would be $p^2 = \frac{A}{I}$; the area $a = 16^2 - (12\frac{2}{3}^2 + 4.8.1\frac{2}{3}) = 43$ the moment of inertia $I = \frac{1}{12}.\ (16^4 - 12\frac{2}{3}^4 - 3\frac{1}{3}.8^3 - 8.16^3 + 8.12\frac{2}{3}^3) = 1799$.

Therefore $p^2 = \frac{1799}{43} = 41{,}8$. Now for rubble-work, Table V, $\left(\frac{c}{f}\right) = 100$; and, from Formula (60), the safe load would be:

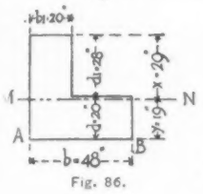


Fig. 86.

$$W = \frac{43.100}{14 + 0{,}046.\frac{26.26}{41{,}8}} = \frac{4300}{14{,}77}$$

= 291 tons; or more than strong enough.

Piers at opening. Now let us examine the strength of each pier by itself, Figure 86. In the first place we must find the distance y of the neutral axis M–N from say the line A B. This from

Table I, Section No. 20 is:

$$y = \frac{\frac{48.20^2}{2} + 20.28.\left(20 + \frac{28}{2}\right)}{48.20 + 20.28} = 18,''8, \text{ or say } y = 19''.$$

Now $i = \frac{20.29^3 + 28.1^3 + 48.19^3}{3} = 272347$ (in inches) and $a = 20.48 + 20.28 = 1520$ square inches, therefore $\delta^2 = \frac{i}{a} = 179$ (inches).

The length of each pier is 18 feet, or

$$L = 18.$$

Therefore, from Formula (59) we have the safe load:

$$W = \frac{1520.100}{1 + 0.475.\frac{18.18}{179}} = 81940 \text{ pounds},$$

or say the safe load on each pier would be 41 tons.

The actual load we know is $\frac{126}{4} = 34\frac{1}{2}$ tons, or the pier is more than safe.

Thickness of walls. Now let us see how far down it would be safe to carry the 20″ walls. We use formula (60) and have from Section Number 4, of Table 1:

$$P^2 = \frac{16^2 + 12\frac{2}{3}^2}{12} = 34\frac{2}{3} \text{ (in feet)}.$$

The area would be

$$A = 16^2 - 12\frac{2}{3}^2 = 96 \text{ square feet.}$$

The load for each additional foot under belfry would be then:

$$96.150 = 14400 \text{ lbs., or } 7{,}2 \text{ tons.}$$

The whole load from top down for each additional foot would be, in tons:

$$w_1 = 126 + (L - 26).7{,}2 = 7{,}2.L - 61$$

While the safe load from Formula (60) would be:

$$W = \frac{96.100}{14 + 0{,}046.\frac{L^2}{34\frac{2}{3}}}$$

Now trying this for a point 50 feet below spire, we should have the actual load:

$$w_1 = 7{,}2.50 - 61 = 299 \text{ tons.}$$

and the safe load:

$$W = \frac{96.100}{14 + 0{,}046.\frac{50.50}{34\frac{2}{3}}} = 554 \text{ tons, or, we can go still}$$

lower with the 20″ work. For 70 feet below spire, we should have actual load:

$$w_1 = 7{,}2.70 - 61 = 443 \text{ tons,}$$

while the safe load:

$$W = \frac{96.100}{14 \times 0{,}046.\frac{70.70}{34\frac{2}{3}}} = 468 \text{ tons, or, 70 feet would be}$$

about the limit of the 20″ work.

If we now thicken the walls to 24″, we should have

$$a = 112 \text{ square feet.}$$

p^2 from Section 4, Table I, $= 33\frac{1}{3}$ (in feet).

The weight per foot would be $112.150 = 16800$ lbs. (or 8,4 tons) additional for every foot in height of 24″ work.

Therefore the actual load would be,

$$443 + (L - 70).8{,}4 \text{ or}$$

$$w_1 = L.8{,}4 - 145.$$

Now, for $L = 80$ feet, we should have the actual load:

$$w_1 = 527 \text{ tons, while the safe load would be:}$$

$$W_1 = \frac{112.100}{14 + 0{,}046.\frac{80.80}{33\frac{1}{3}}} = 491 \text{ tons.}$$

This, though a little less than the actual load, might be passed. Rubble stone work, however, should not be built to such height, good brickwork in cement would be better, as it can be built lighter; for $\left(\frac{c}{f}\right) = 200$, would give larger results, and brickwork weighs less, besides; then, too, we have the additional advantage of saving considerable weight on the foundations.

Thickening the walls of a tower or chimney on the inside does not strengthen them nearly so much as the same material applied to the outside would, either by offsetting the wall outside, or by building piers and buttresses.

It is mainly for this reason, and also to keep the flue uniform, that chimneys have their outside dimensions increased towards the bottom.

Example.

Circular chimneys. *A circular brick chimney is to be built 150 feet high; the flue entering about 6 feet from the base; the horse-power of boilers is 1980 HP. What size should the chimney be.*

The formula for size of flue is:

$$A = \frac{0{,}3.HP + 10}{\sqrt{L}} \qquad (61)$$

Where A = the area of flue, in square feet.

Where L = the length of vertical flue in feet.

Where HP = the total horse-power of boilers.

A circular flue will always give a better draught than any other form, and the nearer the flue is to the circle the better will its shape be.

In our case the flue is circular, so that we will have

$$A = \frac{22}{7}.R^2 \text{ (see Table I, Sec. No. 7) or}$$

$$R = \sqrt{\frac{7.A}{22}}$$

Inserting the value of A from formula (61) we have:

$$R = \sqrt{\frac{7}{22}.\frac{0{,}3.1980 + 10}{\sqrt{144}}} = \sqrt{\frac{7}{22}.50{,}3} = 4$$

or the radius of flue will be 4 feet (diameter 8 feet).

Now making the walls at top of chimney 8″ thick and adopting the rule of an outside batter of about $\frac{1}{4}$″ to the foot, or say 4″ every 15 feet, we get a section as shown in Figure 87.

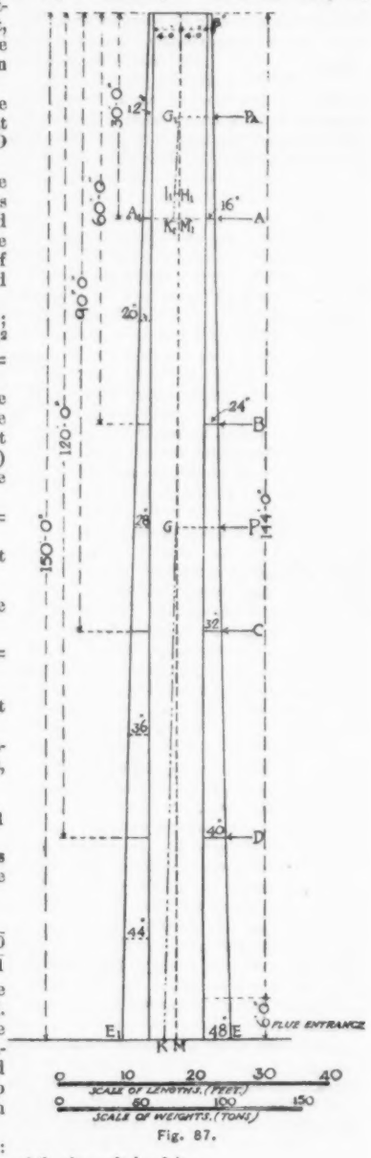


Fig. 87.

Let us examine the strength of the chimney at the five levels A, B, C, D and E.

The thickness of the base of each part is marked on the right-hand section, and the average thickness of the section of the part on the left-hand side.

Take the part above A; the average area is ($\frac{22}{7}.5^2$ — flue area) or, $78 - 50 = 28$ square feet.

This multiplied by the height of the part and the weight of one cubic foot of brickwork (112 lbs.) gives the weight of the whole, or actual load.

$$w_1 = 28.30.112 = 94080 \text{ lbs., or } 47 \text{ tons.}$$

The area of the base at A would be:

$$A = \left(\frac{22}{7}.5\frac{1}{3}^2 - \text{flue area}\right); \quad A = 89 - 50 = 39 \text{ square feet.}$$

The height of the part is $L - 30$.

The square of the radius of gyration, in feet, is:

$$p^2 = \frac{5\frac{1}{3}^2 + 4^2}{4} = 11{,}11$$

Inserting these values in Formula (60) the safe load at A would be:

$$W = \frac{39.200}{14 + 0{,}046.\frac{30.30}{11{,}11}}$$

$= 440$ tons, or about nine times the actual load. Now, in examining the joint B we must remember to take the whole load of brickwork to the top as well as whole length L to top (or 60 feet).

The load on B we find is:

$$w_1 = 131 \text{ tons, while the safe load is:}$$

$$W = \frac{63.200}{14 + 0{,}046.\frac{60.60}{13}} = 472 \text{ tons.}$$

Similarly, we should find on C the load:

$$w_1 = 259 \text{ tons, while the safe load is:}$$

$$W = \frac{89.200}{14 + 0{,}046.\frac{90.90}{15{,}11}} = 461 \text{ tons.}$$

On D we should find the load:

$$w_1 = 432 \text{ tons, while the safe load is:}$$

$$W = \frac{119.200}{14 + 0{,}046.\frac{120.120}{17{,}44}} = 448 \text{ tons.}$$

Below D the wall is considerably over three feet thick, and is solid, therefore we can use $\left(\frac{c}{f}\right) = 300$, provided good Portland cement is used and best brick, which should, of course, be the case at the base of such a high chimney. We should have then the load on E:

$w_1 = 657$ tons, while the safe load is:

$$W = \frac{151.300}{14 + 0{,}046.\frac{150.150}{20}} = 690 \text{ tons.}$$

The chimney is, therefore, more than amply safe at all points, the bottom being left too strong to provide for the entrance of flue, which will, of course, weaken it considerably. We might thin the upper parts, but the bricks saved would not amount to very much and the offsets would make very ugly spots, and be bad places for water to lodge. If the chimney had been square it would have been much stronger, though it would have taken considerably more material to build it.

LOUIS DECOPPET BERG.

[To be continued.]

COMMUNICATIONS.

THE PRACTICAL VALUE OF GROUTING.

NEW YORK, May 10, 1887.

TO THE EDITORS OF THE AMERICAN ARCHITECT: —

Dear Sirs, — In the current number of your valuable paper, Mr. Berg says: "Theoretically, grouting is often condemned, etc., but, *practically*, it makes the best work, and is to be recommended in freezing weather."

In the interest of safe-building construction, of which I claim to have knowledge, I must take an unequivocal exception to the above statement, and maintain that both theoretically and practically grouting is to be condemned, particularly in brickwork masonry, and that no theory is sound that is not based upon good practice and confirmed precedent, and in support of my own opinion and experience I quote the following authorities:

Col. Sedden says: "Grouting is, in reality, only a remedy for bad work, but as it is next to impossible to get the joints filled in solid mortar, and the bricks properly wetted in dry weather, it is often advisable to make use of it."

"Vicat's experiments show," says Mr. Burnell, "that all limes lose two-fifths of their strength if mixed with too much water."

Rivington's "*Notes on Building Construction*" says: "Grouting is deficient in strength, and should not be used where it can be avoided."

Mr. G. R. Burnell, C. E., in his work on "*Limes, Cements and Mortars*," says: "The system of grouting is more than questionable in its results; the lime suspended in it is nearly destroyed, the extra quantity of water is but an addition to the difficulties of setting opposed to the mortar already in place."

General Gillmore indirectly condemns the practice, by saying, "That with the same material the adhesive property varies with the consistency of the mortar and the quantity of sand which it contains."

In every instance the instructions in the preparation of mortar are to add just enough water to slake the lime to a thick paste.

General Totten's experiments show that slaking by "drowning" (for grouting is practically a "drowned" mortar), or using a large quantity of water in the practice of slaking affords weaker mortars than slaking by sprinkling.

Hon. R. M. Bancroft, C. E., in his work on "*Chimney Construction*," says: "Grouting possesses little adhesive power as the water evaporates, and should be discountenanced."

Finally, Mr. Trautwine says: "That unless grouting contains a large amount of cement it is probably entirely worthless, since the great quantity of water injures the properties of the lime, and, moreover, its ingredients separate from each other, the sand settling in the interior of thick masses of masonry; indeed, the same may probably be said of any common lime-mortar. In such positions it has been found to be perfectly soft after the lapse of many years."

In my own practice, I never permit grouting, except for stone masonry, and then only with neat-cement that is quick-setting.

In the interest of safe building and sound architecture, I trust you will find space in your columns for the above remarks.

Yours truly, C. POWELL KARR, C. E.

NEW YORK, May 17, 1887.

TO THE EDITORS OF THE AMERICAN ARCHITECT: —

Dear Sirs, — I confess that I am at a loss to know just how to answer Mr. Karr's "unequivocal exception to" my statement. He sets up his "claim to knowledge," "own opinion," etc., against all "good practice and confirmed precedent," which are decidedly in favor of grouting.

I think that when Mr. Karr has had a little more *practical experience* he will agree with the large majority of the best practical engineers, architects and masons, who thoroughly believe in the efficiency of grouting.

I fear Mr. Karr is a not too careful reader, as he quotes me as recommending grouting in freezing weather, whereas I distinctly condemned its use in such weather. Then, too, he does not seem to notice that all his other quotations but prove my statement, viz., that grouting is often condemned theoretically, but that practically it is good. His very first quotation, from Col. H. C. Sedden (who, by the by, is an English engineer of the largest *practical* experience), distinctly upholds my position.

Very truly yours, LOUIS DECOPPET BERG.

OUR GELATINE PRINTS.

CLEVELAND, O., May 23, 1887.

TO THE EDITORS OF THE AMERICAN ARCHITECT: —

Dear Sirs, — The correspondence in the last number of the *American Architect* has rather interested me, and as people are generally glad of a little sympathy when criticized, I must say that I heartily agree with your remarks with regard to the Detroit Post-office. It is truly a thing most wonderfully made. With regard to Mr. Barnum's remarks, although he is a very good friend of mine, I cannot say that I entirely agree with him regarding the gelatine prints. The Methodist Church at Baltimore, although hardly a thing of our day and generation, is certainly a *tour de force*, and a building which shows on its face that its designer is a man of cultivation. As a whole, I do not think that we can complain of the gelatine prints, although I would prefer to see more foreign and less native work. The home buildings being accessible, and photographs of them easily obtained, while it is rather difficult to get a really good stock of foreign photographs from which to select.

Very respectfully yours, CLARENCE O. AREY.

TEXT-BOOKS.

BALTIMORE, MD., May 12, 1887.

TO THE EDITORS OF THE AMERICAN ARCHITECT: —

Dear Sirs, — I would like to know what book will give me information in regard to strains in construction, sizes of timbers, roof-designing, ironwork, etc.? I desire to make a special study of this branch, but do not know exactly where to begin. A letter direct, or through the *American Architect*, which I see weekly, will greatly oblige,

Yours respectfully, RICHARD JOHNSON.

[KIDDER'S "*Architects' and Builders' Pocket-book*" gives an excellent concise survey of the subject, and any library catalogue will give information as to the innumerable books by the help of which any particular branch may be pursued. — EDS. AMERICAN ARCHITECT.]

A QUESTION OF COMMISSION.

COLUMBIA, S. C., May 14, 1887.

TO THE EDITORS OF THE AMERICAN ARCHITECT: —

Dear Sirs, — I will ask you to advise me, through your next issue, in the case below stated: I agreed to furnish a gentleman plans, specifications and details for two per cent on a building which was to cost about $15,000. The design was accepted, the working-drawings made, and my estimates were $15,660, at which price I would have built the house. The gentleman then concluded that he wanted a cheaper house. I then made a second design, and drew up the specifications, leaving out of contract all ironwork, granite-work, plastering, painting, etc.; when the estimates were opened the contract was let out at $9,000, my figure being high, $12,099. I might here express some regret for the $9,000 man. The owner is to furnish considerable material, etc., himself, and I do not just know what the amount will reach. Kindly inform me on what figure I should reckon my fee.

Please refer me to the most complete schedule of prices of which you know, and you will greatly oblige,

Yours very truly, GEORGE W. WARING.

P. S. I am, of course, entitled to travelling expenses above this fee.

[IT is customary to reckon commission on the actual cost of a building as if constructed entirely of new materials furnished by the builder, without any deduction for what may be furnished by the owner. The common schedule of fees is that published by the American Institute of Architects, a copy of which can probably be obtained by addressing the Secretary of the Institute in New York; or it may be found in Kidder's "*Architects' and Builders' Pocket-book*," and probably in various other publications of the kind. About the travelling expenses, much depends on the terms of agreement with the owner. The schedule, and common usage, regard travelling expenses as a disbursement which the owner repays, in addition to the fee for professional service, but our correspondent seems to have made a special contract, differing from that sanctioned by custom, and it would have been safer to have thought to mention the point, although we incline to the belief that in the absence of any stipulation whatever in regard to the matter, travelling expenses would be generally considered to be payable in addition to the professional man's fee. — EDS. AMERICAN ARCHITECT.]

NOTES AND CLIPPINGS.

THE VALUE OF WATER-GAS IN HEATING AND SMELTING OPERATIONS. — In a recent number of *Dingler's Polytechnisches Journal* are given the results of some interesting experiments carried out at Frankfort-on-the-Main with the object of testing the value of water-gas for heating and smelting purposes. It was found that this gas, made in a Wilson generator, and having the following percentage composition - carbonic oxide, 18; hydrogen, 10; nitrogen, 68; carbonic acid, 4; was

serviceable for the heating of boilers, but unfit for smelting purposes. The melting temperature of silver could hardly be reached, the gas having lost its generating temperature, 400° Centigrade, by the transit from the generator to the furnace. By utilizing this temperature and heating the air of combustion, the ordinary smelting operations could be performed; nevertheless, the use of the Wilson generator was discontinued, because the gas was not cheaper than other fuel for boiler heating. Since 1885 the refining-works at Frankfort have used water-gas, furnished by the neighboring gas-works at 6 pfennige per cubic metre, or about 1*s.* 8*d.* per 1,000 cubic feet. It is not stated by what process the gas is manufactured; but in composition it is identical with the Lowe gas. It is still too expensive for all crude purposes, so that it is only used for melting gold, silver, and their alloys, fluxes, and pigments for the decoration of china, and all purely laboratory work. It was compared with the rich illuminating gas obtained from the Frankfort works, and the poorer gas supplied in the city, the burners used being identical. A copper vessel, filled with water, was heated from 15° to 100° Centigrade, under similar conditions. It took 10 cubic metres of water-gas against 4 cubic metres of Frankfort rich gas, and 5 cubic metres of the poorer gas. Equal weights of two kinds of flux for enamelling-colors were melted under identical conditions, in a Perot furnace. The cost of the gas in each operation was 4.60 and 6.50 marks for water-gas, against 19.6 and 26.8 marks for the rich Frankfort gas. Equal quantities of fine silver and copper were melted with the two gases in the same furnace. It required of water-gas 4.30 and 5.70 marks' worth, and of rich illuminating-gas 16.7 and 21.7 marks' worth. By using water-gas, therefore, all boiling, heating, or evaporating operations can be accomplished for half the money, and all melting for about a quarter the money, as compared with illuminating-gas. It will be seen that this is only the result of the difference in the price of the two gases; for from the first experiment it follows that the pyrometric value of the coal-gas is 2.5 times as high as that of the water-gas.

A Collection of Locks and Keys.— M. Spitzer, an Austrian born in Vienna, but a citizen of Paris, has a mansion in the Rue Villejust containing a most notable collection of masterpieces in works of art. A visitor describes wonderful ironwork found in one of the spacious apartments as follows: "Here are locks and keys of wrought-iron, chased, damascened, and otherwise worked as if the material were as soft as ivory. One wrought-iron lock represents Adam and Eve standing on each side of the Tree of Knowledge, around whose trunk is wound the serpent. The figures are in high relief; the tree with its branches stands out in the round from the tracery background of the lock, and seek as they will the modern smiths cannot discover the secret of its fabrication. Another iron lock has three compartments in the form of a triptych, and on a background of Gothic openwork tracery are figures in high relief and almost in the round. In the middle compartment at the top is God, and at each side an angel; below is Christ and the Virgin Mary, and below them are souls climbing up to heaven or being flung down to hell by attendant devils. In the compartment on the left, Peter, carrying his key, and, aided by two debonnaire angels, is letting souls into Paradise, patting the timid on the head encouragingly. In the right-hand compartment we see hell-fire and quaint devils with long tails prodding unhappy souls and pushing them down into the sea of burning brimstone. On this lock there are nearly 40 figures, each about 2 inches high, and most delicately wrought. The lock is about 9 inches high, each of the side compartments 4 inches broad, and the central panel 6 inches broad. The value of such a piece of work as this cannot be estimated." — *Iron Age.*

The American Exhibition.— But there is no doubt that Exhibition, grounds, switch-back railroad, toboggan-slide, and all the other attractions are but side-shows to the great Wild West entertainment. By no possible stretch of ingenuity can this feature be brought within the scope of criticism in *Engineering*. None the less, however, did a crowd of prominent members of the profession, to say nothing of those eminent in almost every other path of art, science, and industry, enthusiastically follow the prolonged performance that for the first time was given to a British audience a few weeks ago. The grand stand which dominates the arena is large enough to hold nearly 20,000 persons, and of itself is a wonderful spectacle when crowded on every tier and from end to end of its vast sweep. We believe that the Exhibition is practically an American enterprise — we mean that most of the heavy capital required has been furnished from the United States — and we trust that those most deeply interested in the welfare of the undertaking will not be wanting in firm and judicious management — a condition as important as an attractive show. There is little doubt, we think, that if the Exhibition is a success, it will tend largely to increase pleasant and familiar relations between this country and America, while if it should not succeed an opposite result will unfortunately be effected. The public are certainly ready to do their part to bring about the former and much-to-be-wished-for conclusion; it depends, therefore, almost wholly upon the executive.— *Engineering.*

One view of the Natural-gas Question. — A nervous correspondent sends this advice to the Cincinnati *Commercial Gazette*: "From the beginning of the natural-gas 'craze' I have been opposed to it. I believe the boring of gas-wells and the tapping of the gas will result in explosions and destruction of the surface of the earth in the vicinity of said wells. The interior of the earth, I believe, is hollow, and the hollow is filled with a gaseous substance very likely wholly composed of natural-gas. Earthquakes are probably caused by vacuums made by the flowing therefrom of the gas. Now, the interior of the earth being filled with said gas, it discharges the same purpose that the gas does to a balloon. While filled with gas the balloon floats in space. When extracted or consumed it collapses or falls to the ground. So with our earth. Take from it gas enough, as will be done in a few years if this gas craze goes on, and the crust of the earth will become dented and broken as the vacuum increases in size, even should the internal igniting and combustion not take place. Continue the consumption of the gas until the motion of the earth in its orbit is affected and our little earth will lose her place among the heavenly bodies and go crashing to pieces as the balloon falls to the surface when its gas has become expended, or it breaks and lets its gas escape."

The Panama Canal. — A letter from Panama, dated May 11, states that in one of the largest, longest, and deepest cuts, high up above the prospective canal works, water has been struck. The amount of earth and rock taken out of the section referred to has cost millions of dollars. All the work represented by these millions is to-day valueless, as the water has washed from the side of the mountain more than sufficient to fill all the cuts. On the isthmus the purest water is found among the highest strata.

TRADE SURVEYS

Out of the multiplicity of opinions expressed in building, trade and commercial journals concerning the future of trade, two conclusions can be drawn, viz., that a depression is near at hand as a consequence of the extraordinary activity, and that a still greater boom is inevitable in consequence of a permanent expansion in the consumptive capacity of the American people. Pessimists and optimists can be accommodated with ready formulated conclusions from the same raw materials. The facts given and the conditions described favor either one or the other opinion. Wise men will stear clear of expansion of working power, based on debt. The industries are practically debt-clear. Credits in trade are being shortened. Less business is done on credit or promises to pay according to the entire volume than ever before. The volume of business is expanding, while the volume of liabilities of broken concerns is relatively declining. The industries, great and small, are still gaining in strength and activity, but much of their prosperity is intimately connected with the extraordinary railway-building activity. When this limit is reached a reaction must set in. But capitalists who are investing in railway enterprises are strong in the conviction that the present activity will be permanent, that the influx of a million thrifty foreigners per annum and the outflow from the Eastern States will necessitate continued activity. Winter mill-work began pouring in last week. Rails, bridge-iron, plates, and pipes were called for in large quantities. New roads calling for the construction of fifteen hundred miles of road have been projected within two weeks. While English investors exhibit a little customary caution in buying American railway bonds, they are willing to send large blocks of capital for careful investment. Money is abundant; the abstractions of the enormous treasury surplus does not visibly affect the country. The extraordinary absorption of money in reproductive channels does not seem to create a scarcity, nor does the exceptional production in progress show the slightest evidences of an accumulation of stocks or merchandise at forge, shop, factory, mill or mine. These half-dozen or more facts are the factors which the captains in the industries and in finance and trade are now using to solve the, to them, extremely important problem of the probable course of trade and industry for the next year or two. High financial authorities have figured out that investments are now contemplated involving upwards of one hundred million of dollars in railroad, manufacturing, engineering, building, and other enterprises, besides other large investments, in the aggregate, of small operators, whose movements cannot be seen or estimated upon. The debate now is on the point of pushing ahead or waiting. Another point considered is, will more money be made by legitimate investments, or by buying up the wrecks of failure. A moderate panic could and would transfer the title to a thousand or two million dollars' worth of property in a year or two. Will capital add to the mountain of investments, or will it wait for the storm? Have values reached their limit? Are still higher prices probable? Has real estate seen its best? Is the building boom nearing its legitimate limits? Will governmental policies regarding finance weaken or strengthen public confidence in the wisdom and safety of expanding operations? All these and many more questions are passing before the minds of our leading men in railroad management and in manufacturing and commercial channels. The fact that is evident to the layman in such matters is, that the country is entering upon and into new conditions where old rules and measurements do not answer. Another is, that capital-share of reproduction will hereafter be less, that money, in short, will be cheaper, and facilities of every wealth-producing character more abundant. Hence the possibility of an industrial depression is more remote. The housing of the millions will engage more capital.

The movement of a company in a Western city with a capital of five million dollars to build houses for working men is only the first step in a new reform that will ere long be taken in many cities. All past agitations and progress has been in the direction of this one result. Strike agitations fail in Philadelphia because upwards of one hundred thousand houses are owned by laborers. Chicago agitations may be made impossible by similar action. There is every reason why a workman should endeavor to acquire his own home, and the movement has already set in, of modest proportions at present, it is true.

When such a result as this is reached all such questions as are presented in the early portion of this review are set aside. The establishment of new industrial conditions and surroundings will engage the attention of the practical minds of the next decade or two. To-day the industries are in excellent shape even though one hundred thousand men are idle. The examples are not contagious. Labor is more anxious to work than strike. The growth of employers' organization is apparent in nearly every State. The double object will be served, that of protection against labor assaults and against overproduction. The overproduction evil will never be as serious a factor as it has been. Production is now under control. The wisdom of suspension is recognized by producers to the prevention of bankruptcy. Any other restriction has been found difficult and impossible in fact. In manufacturing circles there is a conservative feeling. Summer and autumn orders have been liberally placed by buyers. Jobbers are hopeful. Iron, except in merchant bars, is active. Lumber is in abundant supply. Crop reports are full of promises. Cotton is firm and wool is steady. The distribution of the staple products of New England is satisfactory. The industries of the Middle States are crowded with orders. The Western States are free from the evils of scarce and dear money, and overbearing management of railroad companies. Tens of thousands are building up homes in the far Northwest, and the staples of life are becoming cheaper. The builders, except in Chicago, have a season's contracts on hand, and the season's prospects, both West and South are brighter than at any time.

The American Architect and Building News

ADVERTISERS' TRADE SUPPLEMENT.

No. 60. SATURDAY, JUNE 4, 1887. Volume XXI. No. 597.

MARBLE MOSAICS.

The growing demand for artistic mosaic-work in walls, ceilings, floors, vestibules, etc., etc., is evidenced by the following partial list of well-known public and private buildings in which this form of decoration has been largely employed under the direction of Messrs. Aeschlimann, Pellarin & Company, the pioneers in this class of work in this country:

Mr. W. H. Vanderbilt's Fifth Avenue and Fifty-first Street, New York; Mr. W. K. Vanderbilt's Fifth Avenue and Fifty-second Street, New York; Mr. C. Vanderbilt's Fifth Avenue and Fifty-second Street, New York; Mr. H. Villard's house, Madison Avenue and Fiftieth Street; Mr. G. Kemp's new house, corner of Fifth Avenue and Fifty-sixth Street, New York; S. Marcotte & Company, corner Fifth Avenue and Thirty-first Street, New York; Mr. Sloan's new house, 46 West Fifty-fourth Street, New York; Mr. Goelet's new house, corner Fifth Avenue and Forty-ninth Street, New York; Mr. Arnold's new house, Eighty-third Street, New York; Mr. Constable's new house, Eighty-third Street, New York; Mr. Mott's new house, Fortieth Street, between Lexington and Park Avenues, New York; Mr. Bischoff's new house, Fifth Avenue, between Sixty-ninth and Seventieth Streets, New York; D. E. Adams's new house, Madison Avenue, between Fiftieth and Fifty-first Streets, New York; Dr. Hoyt's new house, 634 Fifth Avenue, New York; Mr. Dana's new house, 25 East Sixtieth Street, New York; Mr. White's new house, corner of Sixty-sixth Street and Fifth Avenue, New York; Dr. Gautier's house, Fifth Avenue, between Ninth and Tenth Streets, New York; Hotel Dakota, Eighth Avenue and Seventy-second Street, New York; Cottier & Company's new house, 144 Fifth Avenue, New York; Mr. Twombley's new house, corner Fifty-fourth Street and Fifth Avenue, New York; Dr. Webb's new house, corner of Fifty-fourth Street and Fifth Avenue; Mr. Tiffany's new house, corner of Seventy-second Street and Madison Avenue; Mr. Dennis's corner of Fifty-fifth Street and Madison Avenue; Lyceum Theatre, Fourth Avenue; Mr. J. P. Scott's new house, Walnut Street, near Twenty-first Street, Philadelphia; Miss Garrett's house, 77 Monument Street, Baltimore, Md.; J. G. Harvey's new house, Baltimore, Md.; T. Harrison Garret's house, Baltimore, Md.; Church of Ascension, Fifth Avenue, New York; Miss Wolf's house, corner of Madison Avenue and Twenty-fourth Street; Messrs. Watson & Company, 229 Fifth Avenue, New York; House Number 309 Commonwealth Avenue, Boston, Mass.; St. Thomas's Church at Mamaroneck, New York; Mr. Robert Garrett's new house, Baltimore, Md.; Mr. J. T. Walter's house, Baltimore, Md.; Mr. Russell's house, Providence, R. I.; Mr. Ross B. Winan's new house, St. Paul St., Baltimore, Md.; Mr. Radford's house at Plainfield, N. J.; Geo. L. Pease, 325 Clinton Avenue, Brooklyn; Emanuel Baptist Church, Brooklyn; Syndicate Building, Washington Street, Brooklyn, and many other well-known houses in New York and other cities.

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Architects can have their own designs executed or artistic and pleasing schemes by capable and efficient artists will be prepared and submitted for their approval on application.

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PORTLAND CEMENT.

A handy little pamphlet on "*Portland Cement*," giving a succinct account of the first gradual and since rapid growth of the use of Portland cement, is issued primarily to set forth the merit of the *Stettin* ("Anchor Brand") of Portland cement, has just been published. It will be found interesting to all architects, engineers, and masons. The eminent German engineer, Dr. Bohme, director of the Royal Commission for testing building materials, at Berlin, the engineers of the New Croton Aqueduct, New York, and others, give recent tests made by them, of its fineness, tensile strength, etc., when mixed neat, and also when mixed one-part cement and three-parts sand. There is also, as a very useful guide to users of Portland cement for sidewalks and cellar floors, an appropriate table of the capabilities of a barrel of Portland cement of four hundred pounds. This little brochure will be sent free on application to

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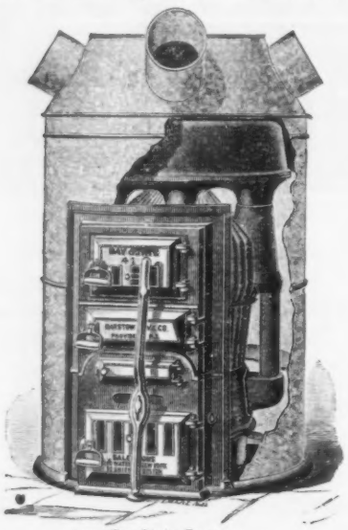
A NEW FURNACE.

Along with the increasing use of furnaces, people are coming to understand better the qualities demanded in a first-class furnace.

The furnace question used to be one which the average householder paid little heed to, and on which he did not pretend to hold an intelligent opinion. The trade has always been in advance of the public in this matter, and has brought out many improvements in furnaces, of late years. These improvements have related to their durability, economy of fuel, the better quality of air delivered by



Bay State Furnace.

them, and other points of advantage. Among the old and successful manufacturers of furnaces in this country is the Barstow Stove Company of Providence, Boston and New York. We herewith illustrate their latest production, the Bay State Furnace. Its form, internal construction, and great radiating surface make it a powerful heater. The joints are exceptionally strong, firm and gas-proof. Its oscillating centre dumping-grate, the arrangements for perfectly and easily regulating the fire, and other operating features, commend it to the trade and to the public. The manufacturers claim that in the Bay State furnace they have met a want long felt by the trade for a first-class cast-iron furnace, low in both height and price. They have surely met the former want which allows of its being put in low cellars and allowing a good elevation to the hot-air pipes. Their combination-check and dust-damper in the base is new and novel as is their grate which shakes with upright shank, doing away with the common back-breaking method usual to furnaces in general. It is made portable and for brick-setting.

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In highway bridges some of the heaviest of its class can be seen at:

Chicago, Chicago Ave. Viaduct; St. Louis, Eighteenth Street Viaduct; Rochester, N. Y., Canal Draw-bridge; Springfield, O., High Street Bridge; Harrisburg, Pa., Canal Bridge; Defiance, O., English Bridge.

Numerous examples can also be seen in the cities of Pittsburgh and Allegheny, nearly every county in Pennsylvania, and a majority of the United States.

Roofs have been built by us for:

U. S. Pension Building, Washington; County Court-House, Pittsburgh; County Court-House, Galesburg, Ill.; County Court-House, Washington, Ia.; Insane Asylum, Clarinda, Ia.; Water-Works, Chicago.

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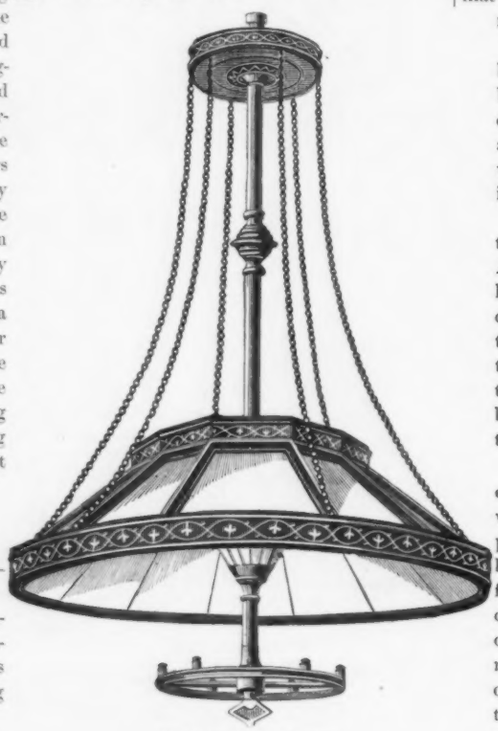
Architects are very generally using our reflectors and reflecting-chandeliers for lighting their public buildings, churches, etc., and we are indebted to your paper very largely for their introduction, as through it is about the only way that we can gain an audience with the leading architects.



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Among the more prominent of the work on which we are now engaged are the following buildings:

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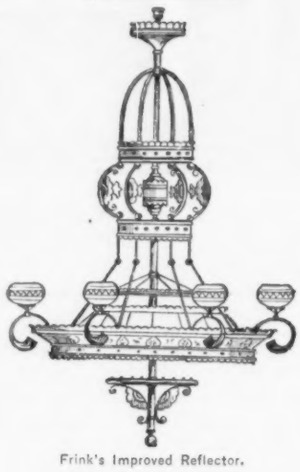

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HAMPDEN PAINTS.

It was Thoreau who said: Color is to the eye what music is to the ear. Emerson remarked that the artistic use of paint distinguishes the homes of civilization from the huts of the savage. Ruskin observed that paint is economical, because it preserves; educational, because it beautifies. And Talmage has added that the man who never paints his house is not likely to brush his clothes.

Except a lady's face most things are the better for paint. But no one desires to be himself, or have his belongings, "off color." Hence, a practical study of paints and painting is a necessity, and these words are written as a guide to the doubting in all such matters.

The poet had the idea that in the springtime the young man's fancy turns to love. And in the same season of the year, the householder is wont to yearn for a new coat of paint. Then should he remember that it costs much more to apply paint than it does to buy it, and just as much to put on a poor coat as a good one. The bill for the painting is commonly from two to four times that charged for the paint.

The days of "Auld Lang Syne," when every country home had glaring white walls, garnished with green blinds, have passed away. Regarding this method of house-painting, Downing writes: "Nature, full of kindness to man, has covered most of the surface that meets his eye in the country with a soft green hue, at once refreshing and grateful. Many of our country houses appear to be painted on the very opposite principle; and one needs, in broad sunshine, to turn his eyes away from them for relief, by taking a glimpse of the soft, refreshing shades that everywhere pervade the trees, the grass, and the surface of the earth." The use of colors admits of different tints and pleasing contrasts on the same building, and greatly modifies the monotonous appearance of village common and city street.

To work, look and wear well these three things are the ult matum to be desired in buying paints. A gallon of paint composed of the best materials thoroughly combined will,

in consequence of its superior "body" and opacity, cover from twenty to twenty-five per cent more surface than a gallon of such paints as are commonly sold. Consequently, if you are going to paint a house, barn, factory, roof, boat, fence, sign, or kitchen floor, the best is the cheapest. It is no economy to use cheap paints or those easily decomposed by the gases of the air.

King Lead is deposed from the throne he has so long held in the minds of painters, who have regarded him as the only pigment suitable for a good paint, experience showing that better results are secured by combining other substances with lead. And these latter days have also proved, beyond a doubt, that a large manufacturer by skilfully using modern appliances is able to make a better paint than can possibly be produced by hand. Prepared paints from reliable manufacturers are invariably uniform in body and color, matching given samples by letter or number. They save time, money, and patience.

Thirty-five years ago the Hampden Paint and Color Company was organized at Springfield, and has since enjoyed a continued career of increasing prosperity. We have to-day a world-wide reputation, which we are bound to maintain. Our Ready-Made Paints are strictly first-class, and are put on the market in every variety of color or shade. They are prepared for immediate use and are convenient, easily applied, economical, durable, and beautiful. We guarantee them to be equal to those of any manufacturer, and if buyers are not satisfied, we shall consider it a favor to have the goods returned to us, or our general agents, at our expense.

You are color-blind to your own interest, provided you intend to do any painting, unless you send for our color-cards, with full directions for ascertaining the amount of paint required for a given surface and instructions for applying same.

We have general agents in each large city. If you cannot buy your paints near home, send us a postal-card and we will mail you our sample-cards and price lists.

Our Ready-Made Paints are not chemical, patent, rubber, fire-proof, or thick paste. They are manufactured and put up ready for use, no oil or dryers need be added to make them ready for the brush.

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NOTES.

WE note that The Wainwright Manufacturing Co., of 65 and 67 Oliver Street, Boston, have shipped their Feed-Water Heaters to the following localities during the month of May: Six to New York City, one each to Buffalo and Troy, N. Y., Athol, Chelsea, Greenfield and Waltham, Mass., Manchester, N. H., Greenwich, and Willimantic, Conn., Yokohama, Japan, Truro, N. S., and two to Montreal. They advise us that they have many and large orders ahead, and pronounce business as "rushing."

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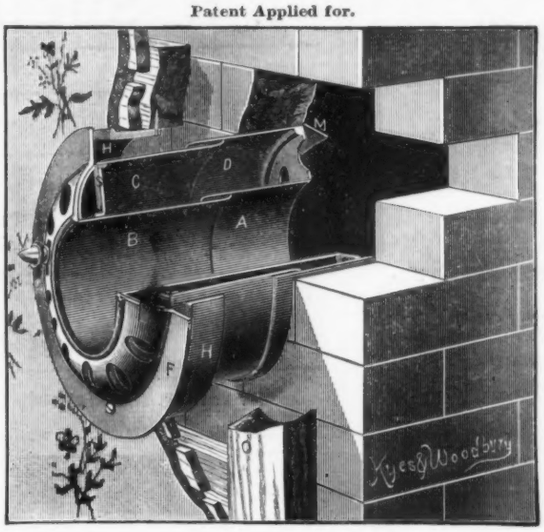

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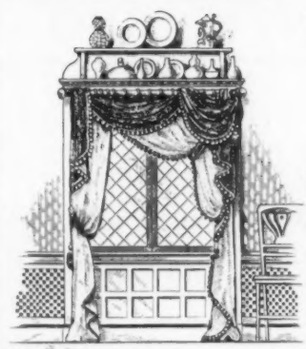

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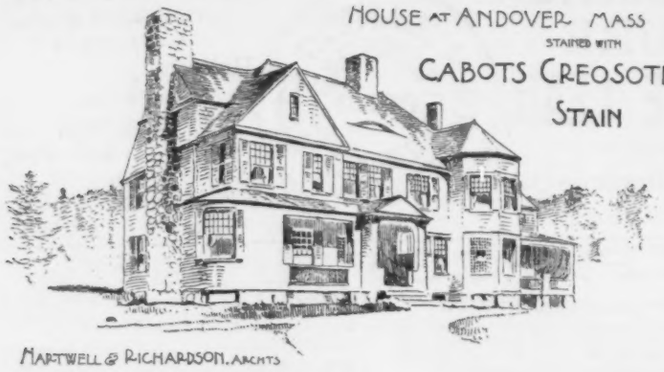

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